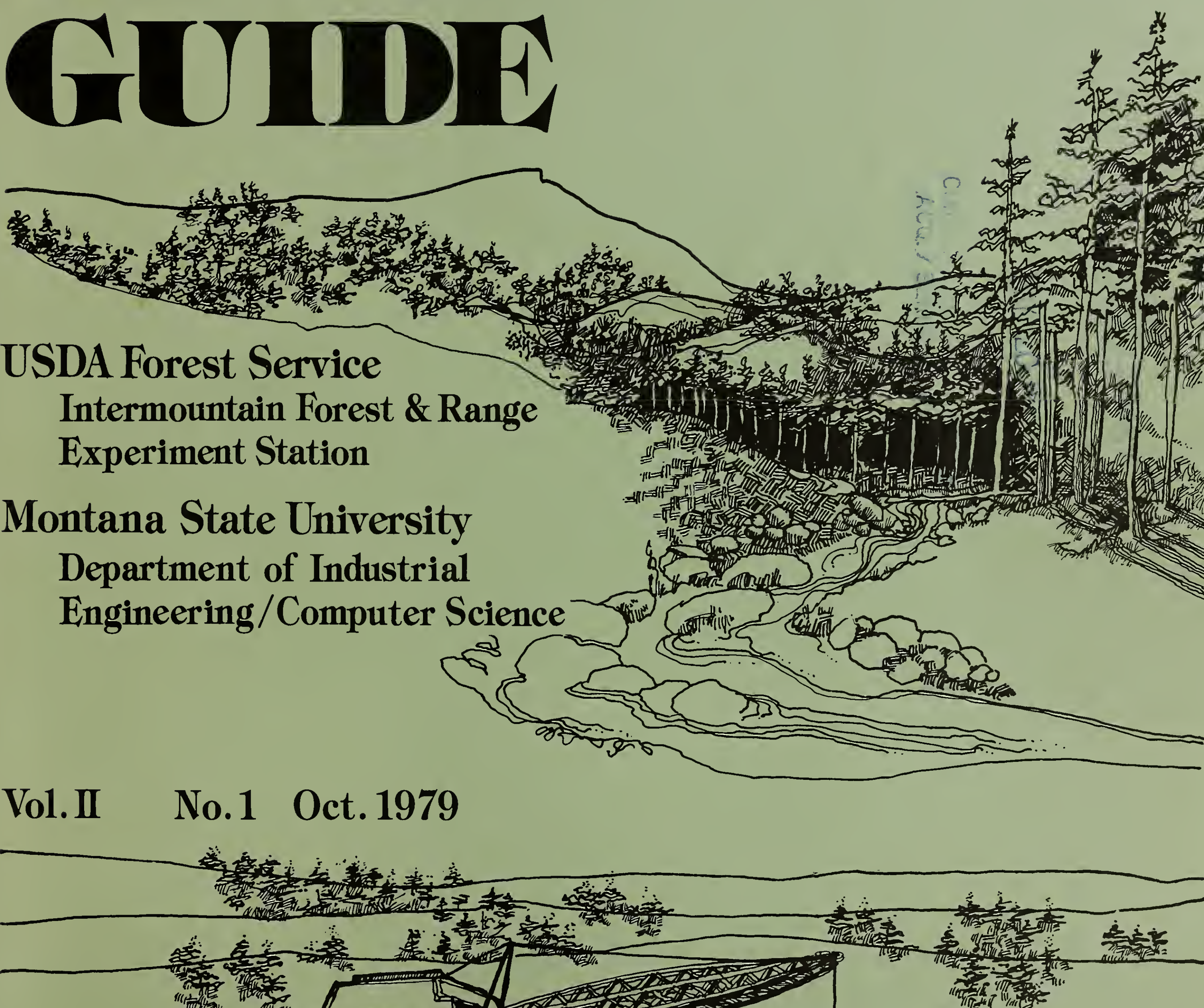
# AMPLAN USER'S GUIDE



USDA Forest Service
Intermountain Forest & Range
Experiment Station

Montana State University
Department of Industrial
Engineering/Computer Science

Vol. II No. 1 Oct. 1979

SURFACE ENVIRONMENT & MINING
SEAM
USDA FOREST SERVICE PROGRAM

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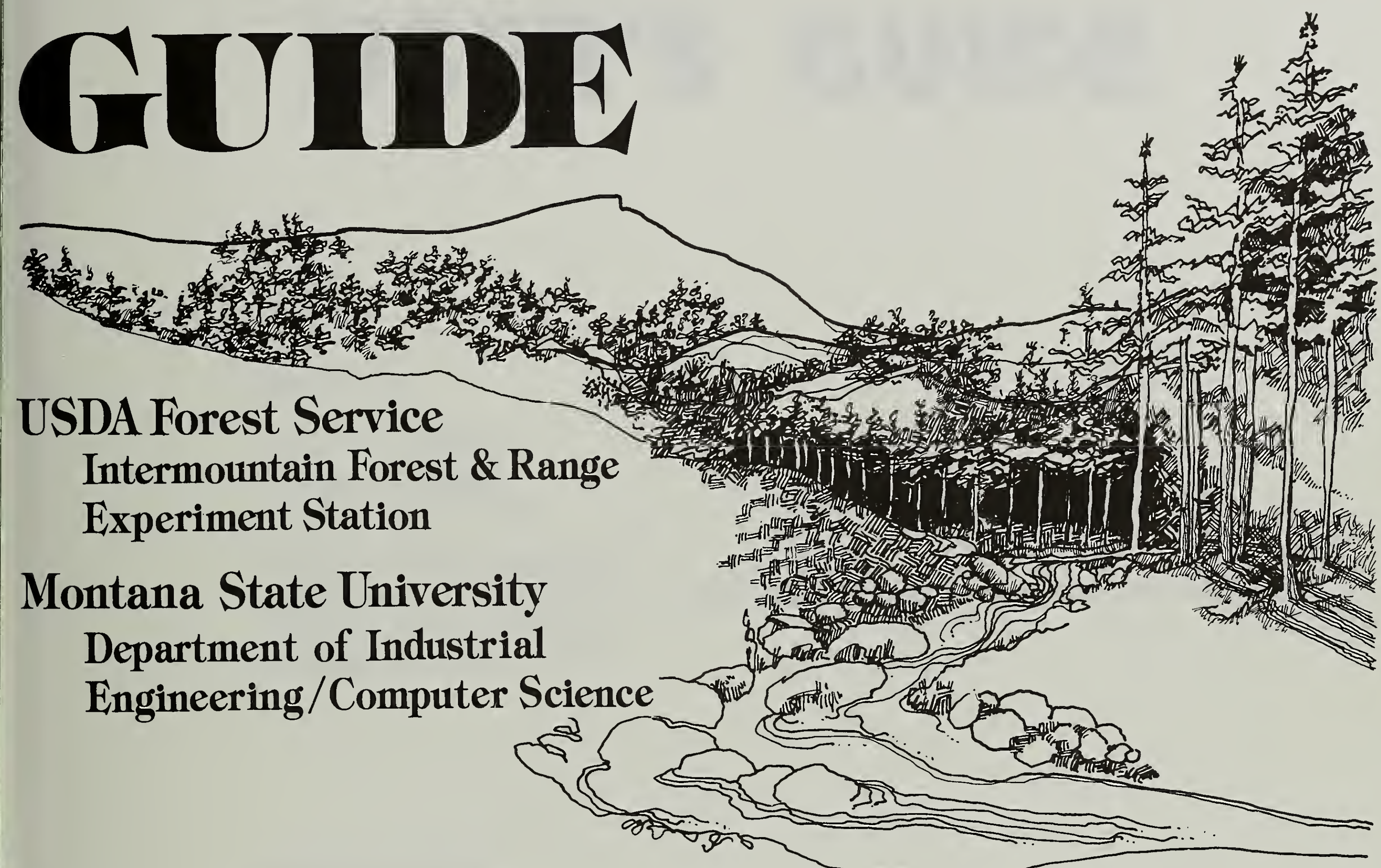

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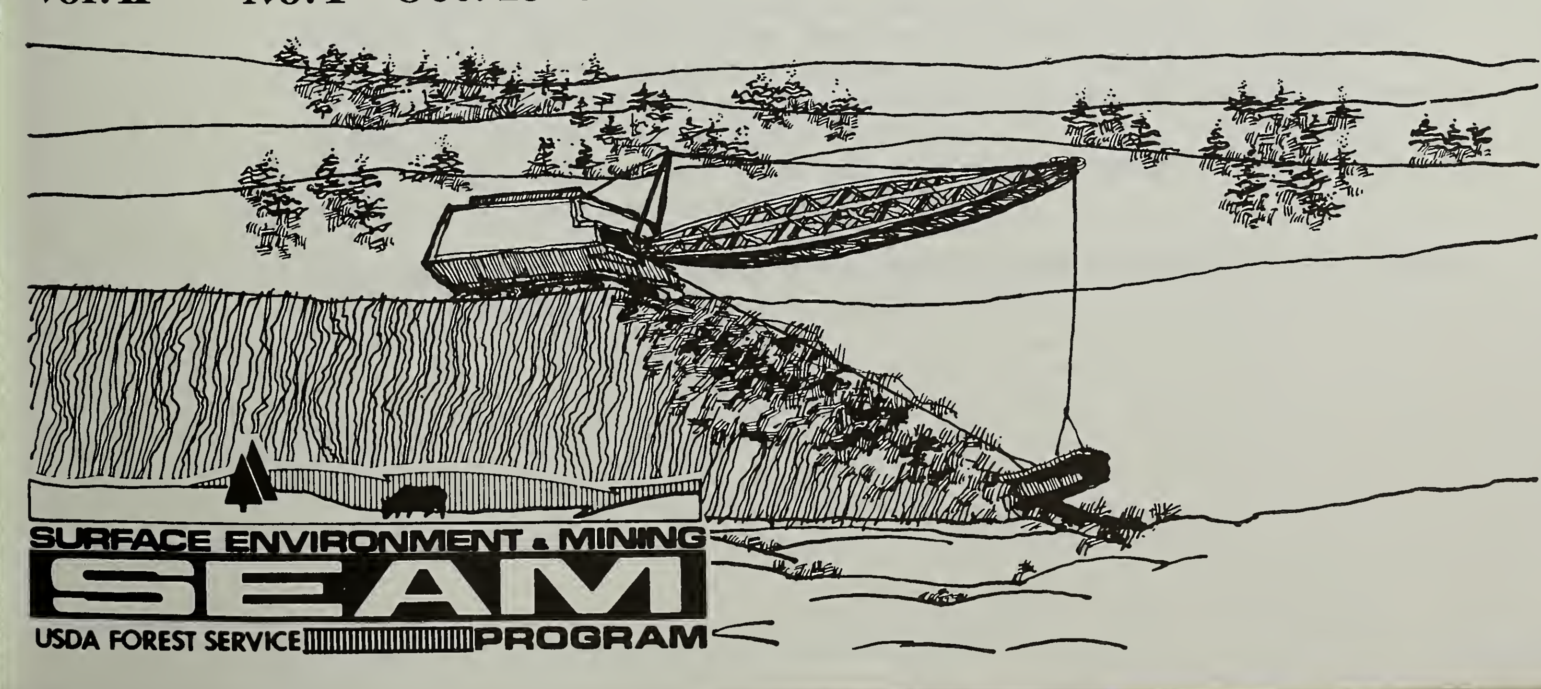

SURFACE ENVIRONMENT & MINING
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# SEAMPLAN

# USER'S GUIDE

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## GENERAL COMMENTS -- ALL VOLUMES

The Surface Environment and Mine Planning System (SEAMPLAN) reported in three volumes, provides an integrated computerized planning system for evaluating surface coal recovery consistent with minimal impact on environments.

The SEAMPLAN System was developed on a Hewlett Packard minicomputer using the RTE III operating system in a highly modular software design. Its organization revolves around three functional modules:

1. Data Entry and Review
2. Production Analysis
3. Impact Analysis.

Each module is divided into programs which combine a user's knowledge gained through interactions with information found in standard data files. In this way an unfamiliar user is quickly provided with a broad range of computing capability.

In addition to Roman numeral designation, all three volumes in SEAMPLAN are given Arabic numeral "1". Future reports, which may be new, but related material, or elaborations and other extensions of current material, will be given sequential Arabic numeral designations.

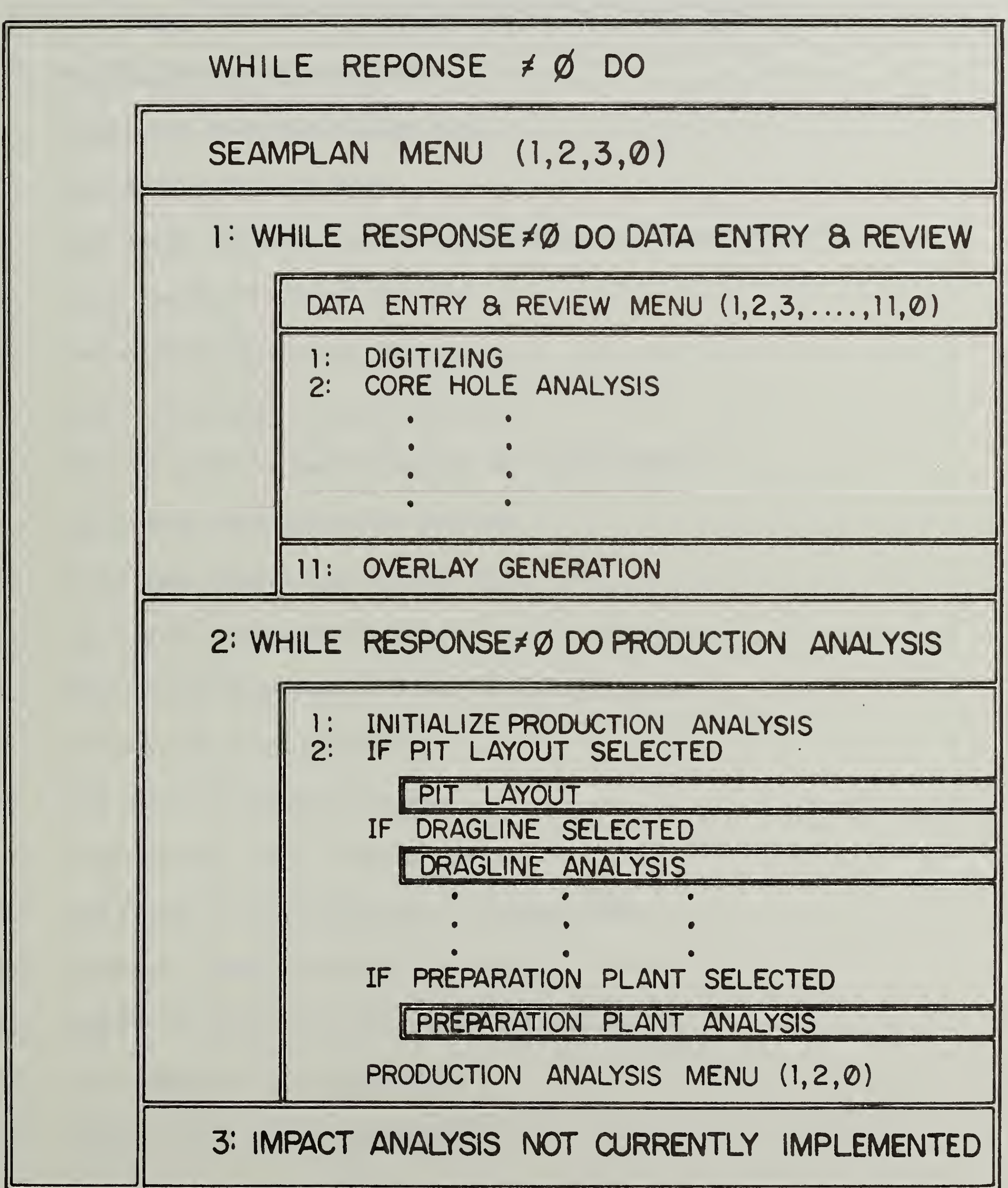
Volume I (OVERVIEW) is a stand alone manual giving a history of surface mining and a sequence of operational events relating to development of a mining plan. It describes acquisition, adaptation, and development of applications software necessary for efficient operation. A user is assisted in selecting equipment for setting up a project and applying the programs.

Volume III (SEAMPLAN Program Documentation) is a stand alone manual giving a broad overview of all programs in SEAMPLAN via data sheets. Program descriptions and logic are included where necessary. Data layout charts show types of data used in programs and how they are input and output. An appendix contains system routines.

## GENERAL COMMENTS -- VOLUME II

The major purpose of the USER's GUIDE is to give step-by-step procedures for a manager, engineer, or interested user to successfully apply SEAMPLAN without the benefit of selecting and setting up a system or without in-depth knowledge of the mathematical modeling and computational logic internal to it.

USER'S GUIDE MAP *HIERARCHIAL OVERVIEW OF SEAMPLAN USER INTERACTION--DEPICTS BRANCHING ROUTINES EXPANDING TO MANY HUNDREDS AND THEREFORE ARE NOT SHOWN.



## FIGURES

## FIGURES (CONTINUED)

# TABLES

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To begin, a user must have access to certain computer equipment, functional and on-line. The equipment may be identical to those used by SEAMPLAN developers at Montana State University or their equivalent.

Table 1. -- SEAMPLAN Hardware/Software

| USER NEEDED EQUIPMENT | SEAMPLAN DEVELOPER'S EQUIPMENT |
|---|---|
| Minicomputer | HP-9600 Series w/RTE III |
| Large Disc Drive | HP-7920 Disc Drive |
| No Equivalent | Tektronix 4014-1 Graphics Terminal |
| Hard Copy Unit | Tektronix 4631 Hard Copy Unit |
| Digitizer | Tektronix Digitizing Tablet |
| Large Drum Plotter | CALCOMP 1037-40 inch Drum Plotter |

## EXECUTING SEAMPLAN

Hit carriage return key on the Tektronix 4014. "09>" will appear, which is a Hewlett-Packard prompt symbol. Correct prompts must precede commands.

Following and on the same row with "09>", type "RU, FMG" and hit carriage return. The file manager program will run.

A colon prompt should appear in the second row as a result of the previous carriage return. Now type the command ":PLANIT", and the terminal scope should display:

"<u>09 ></u> RU, FMG<br><u>:</u>: PLANIT",

where prompts are underlined.

Hit carriage return key, which activates other system commands through ":PLANIT", and the SEAMPLAN program activates by displaying a "menu" on the terminal scope (Figure 1).

```
XXXXXXXXXXXXXXXXXXXXXXXX
X                      X
X  SEAMPLAN EXECUTIVE  X
X   OPTION SELECTION   X
X                      X
XXXXXXXXXXXXXXXXXXXXXXXX


1 -> DATA ENTRY-REVIEW
2 -> PRODUCTION ANALYSIS
3 -> IMPACT ANALYSIS
0 -> TERMINATE

INPUT -> OPTION ?
```

*Figure 1.*-- SEAMPLAN Executive Menu.

Select a desired option and execute by typing option number followed by hitting carriage return. A second level menu, or query for input data, will be displayed. For instance, if option 1 was selected, the second menu display would be that shown in Figure 2. Programs in menu 2 may now be accessed to input, analyze, manipulate, and display various types of mining information.

Option 2 will, as the menu in Figure 2 implies, allow access to programs that perform interactive pit layout and to a variety of models for analyzing the entire mining design.

Typically, as shown in Figure 1, data entry and review precedes production analysis, since data are automatically carried from the first activity forward. Production analysis may begin first, however, provided necessary data files were previously initialized.

```
XXXXXXXXXXXXXXXXXXXX
X                  X
X   ENTRY-REVIEW   X
X OPTION SELECTION X
X                  X
XXXXXXXXXXXXXXXXXXXX


1 -> MAP DIGITIZING
2 -> CORE HOLE DATA ANALYSIS
3 -> UNIFORM GRID CONSTRUCTION
4 -> GRID INTERPOLATION
5 -> GRID OPERATIONS
6 -> GRID SECTION DISPLAY/EDITING
7 -> THREE DIMENSIONAL SECTION DISPLAYS
8 -> CONTOUR DISPLAYS
9 -> THREE DIMENSIONAL GRID DISPLAYS
10-> LP DATA OUTPUT
11-> OVERLAY CONSTRUCTION
Ø -> TERMINATE

INPUT -> OPTION ?
```

*Figure 2.*-- Data Entry and Review Menu (query for input data).

Data Entry and Review option menu, (Figure 2) became available after selecting option 1 of the SEAMPLAN executive option menu, (Figure 1) followed by a carriage return. Numerous programs are accessible through data entry option by first selecting one of the initial 11 options shown in Figure 2,* hitting carriage return, and then selecting one of several options given on yet another sub-menu (options 1-3 are complex with considerable branching to other menus; options 4-11 simply query, no branching).

Computer queries and option branching form a pattern to expect throughout this guide. The procedure is always the same - select an option code number, type in number, hit carriage return and await display information and corresponding queries. See USER'S GUIDE MAP, page iv.

## MAP DIGITIZING

(Invoked by option 1, data entry menu; see Figure 2)

Gives three options (Figure 3) for inputting data via digitizing tablet, where data are distinguished by digitizing methods and applications:

1. Continuous data -- input and stored as connected vectors. Examples are contours, roads, boundaries, and line data associated with maps,

2. Random XYZ type data -- usually input to other programs written to construct uniform grids in response to another option from data entry menu. X and Y represent planar point locations; Z, point elevations,

3. Point data -- located and tied to single points on map. Examples are farm houses, wells, and archeological sites.

Digitizing options separate into three categories:

---

* By answering a query with Ø (TERMINATE), which is the 12th option, user will leave data entry menu and simply back up to SEAMPLAN executive menu. This pattern holds throughout.

1. Responses to requests for input (no digitizing)
2. Option branching to more menus (no digitizing)
3. Command entry (for digitizing, enter via terminal keyboard to control program activity).

## CONTINUOUS DATA DIGITIZING

Select option 1 from map digitizing menu (Figure 3). Figure 4 will be displayed on terminal.

Answer each input query:

1. Name the file under which continuous data will be placed

2. Give cartridge number under which file will reside (normally, user has an assigned cartridge)

3. Build a new file or add on to an existing file

4. Name job or other header information, which will be placed in file with data

5. Select an integer value for contour intervals (program will draw all contours that are multiples of chosen integer; e.g., an input of 1 ensures that all contours are drawn, an input of 2 would show contours with even-valued elevations on the terminal)

6. Select a scale factor for the map (if in doubt, trial and error will succeed)

7. Enter a minimum X and Y value separated with a comma (again, trial and error may be desirable).

The final answer to above queries followed by a carriage return will clear screen and begin new queries one at a time for orienting the map:

1. Locate on map with digitizing pen or cursor the lower left hand corner

2. Locate on map with digitizing pen or cursor the lower right hand corner

3. Locate Y axis range by touching pen or cursor to any point along upper edge of map.

Clear screen as before and menu shown in Figure 5 will appear (all subsequent map routines for orientation are identical). Each record type (key 1-5) yields a different vector format on map. Notice that this menu also allows user to terminate the digitization process (key Ø), close and purge current file (key 7), or simply show what current map looks like (key 6), assuming a map was started.

```
XXXXXXXXXXXXXX
X            X
X DIGITIZING X
X  OPTIONS:  X
X            X
XXXXXXXXXXXXXX


1 -> DIGITIZE CONTINUOUS DATA
2 -> DIGITIZE RANDOM DATA
3 -> DIGITIZE POINT DATA
Ø -> TERMINATE
INPUT -> OPTION ?
```

*Figure 3.*-- Map Digitizing Options Menu.

```
XXXXXXXXXXXXXX
X            X
X DATA ENTRY X
X CONTINUOUS X
X    DATA    X
X            X
XXXXXXXXXXXXXX

INPUT -> FILE NAME ?
INPUT -> CARTRIDGE # ?
INPUT -> NEW FILE (Y/N) ?
INPUT -> JOB NAME (UP TO 2Ø CHAR.'S) ?
INPUT -> CONSTANT INTERVAL BETWEEN CONTOURS ?
INPUT -> SCALE FACTOR (UNITS / INCH) ?
INPUT -> MINIMUM X AND Y VALUE ?
```

*Figure 4.--* Continuous Data Digitizing Menu.

```
XXXXXXXXXXXXXXX
X             X
X RECORD TYPE X
X  OPTIONS:   X
X             X
XXXXXXXXXXXXXXX

1 -> CONTOUR
2 -> ROAD
3 -> WATER (STREAM)
4 -> BOUNDARY
5 -> OTHERS
6 -> SHOW THE MAP TO DATE
7 -> CLOSE AND PURGE CURRENT FILE
0 -> TERMINATE
INPUT -> OPTION ? 1
```

*Figure 5.*-- Record Type Options Menu.

Selection of record types 1-5 will clear screen and issue a request for input. Record type 1 (contour) requires an elevation from the map. Following this, or if record type 2-5 is chosen, the computer will print out operating instructions for digitizing (Figure 6). Now, enter one of four commands through keyboard terminal and location data through digitizing pen or cursor (when digitizing, data are displayed in lower right hand corner of screen):

1. "E" command stops current record and starts another record of same type

2. "T" command stops current record and lets user choose a new record type (typically, digitize all contours first, then digitize roads and other type data as desired). This command also called up Figure 5 automatically from which user may select option #6 (show the map to date), which in turn calls up Figure 7.* Again, new options will apper on the screen (Figure 7):

   2.1. A hardcopy may be generated

   2.2. Small areas may be enlarged (zoomed) for better resolution by entering new boundaries with crosshairs (cursor)

   2.3. Contour intervals may be changed on unzoomed map by first answering Y (yes), then answering interval query with desired size. Map will be redrawn for selected new contour interval.

3. "Q" command stops digitizing process and saves current map in a file

4. "S" command shows map to date as explained previously.

## RANDOM DATA DIGITIZING

Select option 2 from digitizing menu (Figure 3). Figure 8 will be displayed on terminal. The computer responds by requesting a file name in which data are stored. Next, user is asked to digitize each of the left and right hand corners of the map as well as a point along the upper edge of the map in order to orient the map on the tablet. The user will respond to each request individually by locating either the digitizing cursor or pen at the appropriate point on the map.

---

* Sole procedure for viewing a current continuous data map in a file during digitizing process.

```
XXXXXXXXXXXXXXXX
X              X
X  OPERATING   X
X INSTRUCTIONS X
X              X
XXXXXXXXXXXXXXXX

DIGITIZE THE RECORD, AND THEN ENTER
THRU THE TERMINAL EITHER AN
E - TERMINATES CURRENT RECORD AND
    STARTS ANOTHER RECORD OF THE SAME TYPE
T - TERMINATES CURRENT RECORD AND
    ALLOWS YOU TO CHOOSE A NEW TYPE
S - SHOWS THE MAP TO DATE
Q - INDICATES YOU ARE THRU BUILDING IN THIS FILE
```

*Figure 6.*--Digitizing Commands Following Selection of Record Type.

```
XXXXXXXXXXXXXXXXXXXX
X                  X
X PREPARATION DATA X
X CONTOUR DISPLAYS X
X                  X
XXXXXXXXXXXXXXXXXXXX

TEST 8 2 79
FILE: STEFTC

        MINIMUM      MAXIMUM
X:    .0000E+00   .1132E+03
Y:    .0000E+00   .1322E+03
Z:    .2300E+02   .2300E+02
GRID INTERVAL:    .1322E+02
CONTOUR INTERVAL:    .1000E+01

XXXXXXXXXXX
X         X
X   MAP   X
X   KEY   X
X         X
XXXXXXXXXXX
CONTOUR            :
ROAD               :
WATER (STREAM)     :
SUB-BLOCK BOUNDARY:
OTHERS             :

INPUT -> HARDCOPY (Y/N) ? N
INPUT -> ZOOM (Y/N) ? Y
USE THE CURSORS TO
(1) ENTER THE LOWER
    LEFT HAND CORNER
(2) ENTER THE UPPER
    RIGHT HAND CORNER
INPUT -> CHAR. TO CONTINUE
```

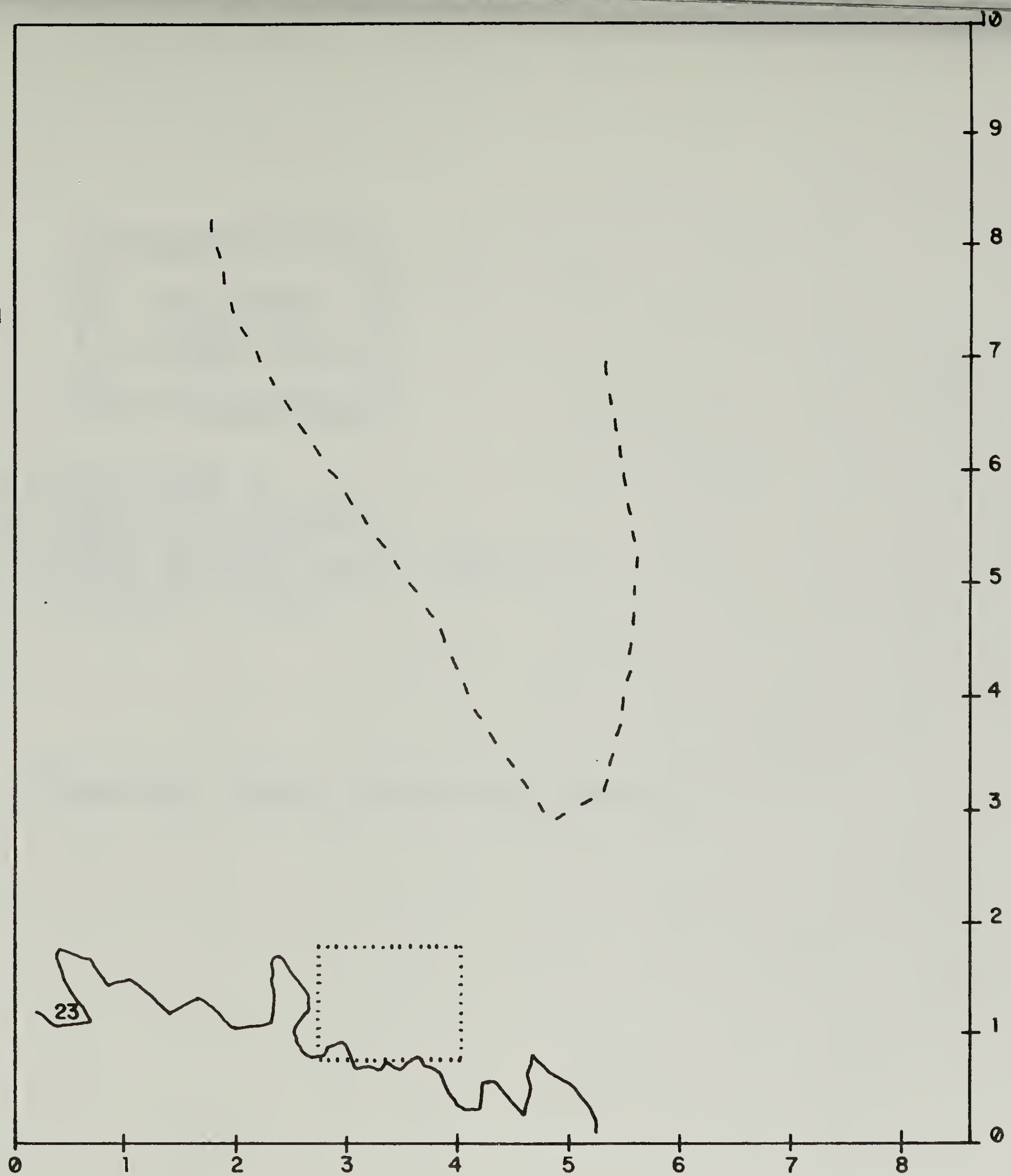



*Figure 7.*--"Show The Map To Date" Display.

```
XXXXXXXXXXXXXXXXXX
X                X
X   DATA ENTRY   X
X    DIGITIZE    X
X DISCRETE DATA  X
X                X
XXXXXXXXXXXXXXXXXX

INPUT -> FILE NAME ?
INPUT -> CARTRIDGE NUMBER ?
INPUT -> NEW FILE (Y/N) ?
INPUT -> SCALE FACTOR (UNITS INCH) ?
INPUT -> MINIMUM X AND Y ?
```

*Figure 8.*-- Random Data Digitizing Menu.

Following map orientation the CRT screen will be cleared and the user will be asked to input a starting elevation which will be associated with X, Y points to be located using the digitizing tablet and the cursor. Once an elevation is entered followed by CR, the screen will once again be cleared and the random data digitizing options for instructions are presented on the screen. At this point, digitizing normally begins with the user locating X, Y pairs by depressing the pen or cursor on the map.

While digitizing, points will be drawn on the screen as shown in Figure 9.

Furthermore, the user may enter the commands shown via the keyboard as appropriate. The user may, as shown, delete random points which were entered one step previously, terminate the current elevation and therefore specify a new elevation, or purge the file currently being built (this would result in a restart of the random data digitizing), or show the points currently associated with the random data file. He may also terminate with a closing and saving of the random data file by electing the "Q" option.

Once the user has selected one of the options he may digitize points until another command is entered via the keyboard. Should the user decide to show the location of all the points that have been digitized, a display similar to Figure 10 will be presented on the Tektronix screen. This figure shows the location and internal numbering of all points entered to date.

Once the display is completely drawn the user is asked to indicate whether a line printer listing of elevations is desired. Such a listing and/or the CRT point display will be helpful later during grid construction.

Should he not wish a line printer listing of the X,Y,Z point sets, or following such a listing the user will be requested to strike any keyboard character to continue. At this point he will be once again presented with the operating instructions and the allowable commands list shown in Figure 9. Operation will continue in this manner until terminated with the file saved ("Q") or write it purged ("P").

## POINT DATA DIGITIZING

Should the user elect to digitize points data will begin following clearing of screen. As each question shown in Figure 11 is written to the screen, the user must enter an appropriate answer following the question mark. In response to the first question, a file name for the point data file less than or equal to six characters long must be entered.

The second question asked the user which cartridge the file should be placed on. This will typically be the user's cartridge number. Next, the user is asked to enter a job name which will identify this particular set of data, followed by a request for a symbol table name.

```
XXXXXXXXXXXXXXXX
X              X
X   OPERATING  X
X INSTRUCTIONS X
X              X
XXXXXXXXXXXXXXXX

DIGITIZE EACH POINT ON THE CURRENT ELEVATION
A TERMINAL INPUT OF THE FOLLOWING CHARACTERS
IS ALLOWED:
(D) - POINT JUST ENTERED IS DELETED
(E) - TERMINATES CURRENT ELEVATION
(P) - PURGE THE FILE CURRENTLY BEING BUILT
(S) - SHOW THE POINTS AND ELEV'S TO DATE
(Q) - QUIT
```

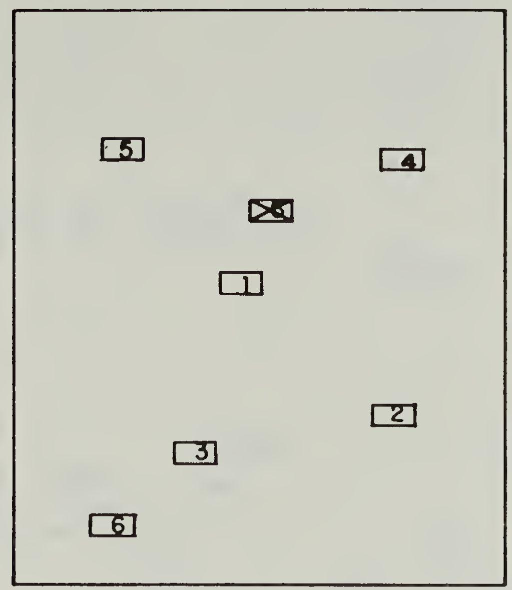
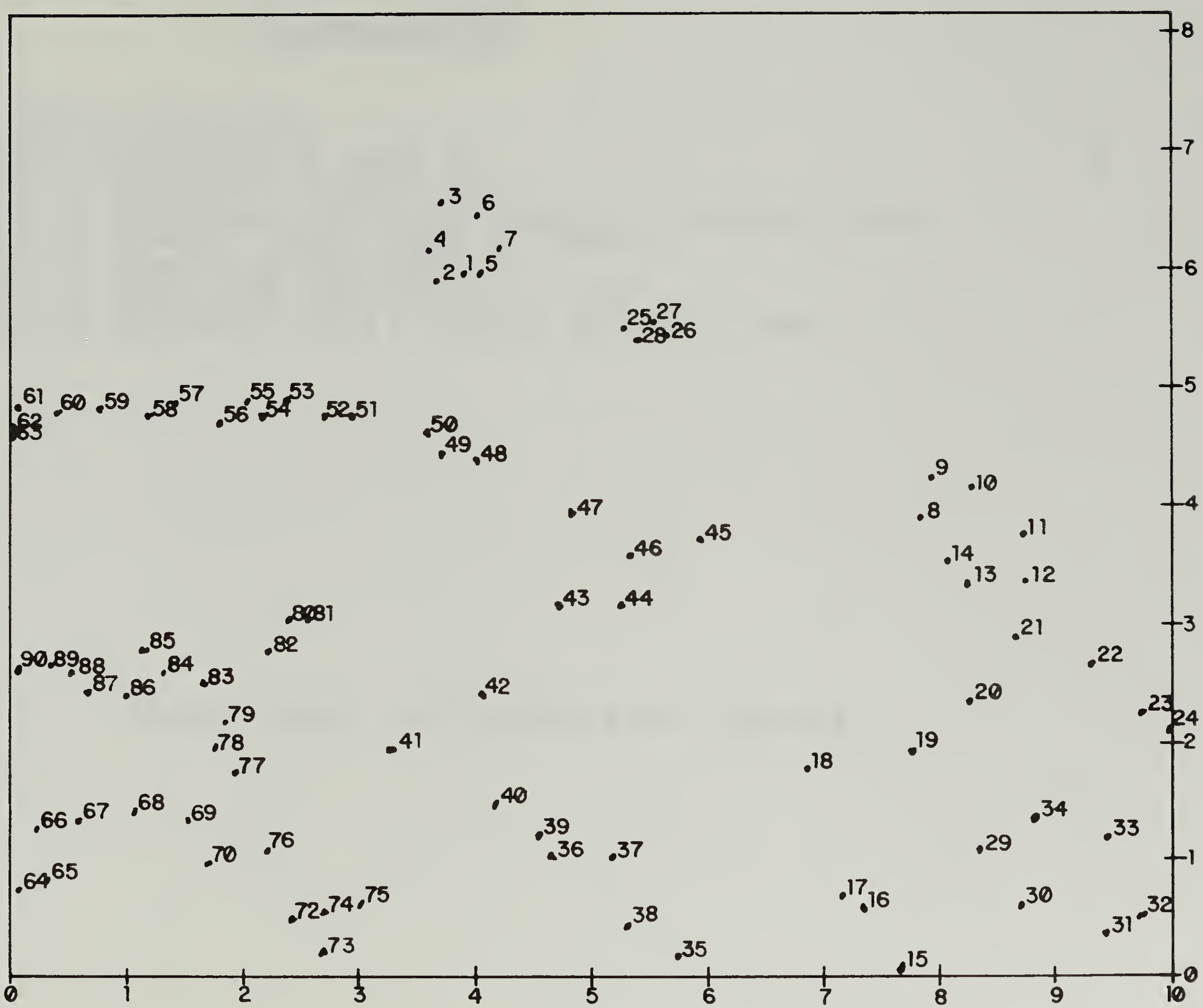



*Figure 9.*-- Random Data Digitizing Interaction.

```
XXXXXXXXXXXXXXXXXXXX
X                  X
X PREPARATION DATA X
X CONTOUR DISPLAYS X
X  DISCRETE DATA   X
X                  X
XXXXXXXXXXXXXXXXXXXX
```

FILE: TEMP 2

| | MINIMUM | MAXIMUM |
|---|---|---|
| X: | .0000E+00 | .4173E+04 |
| Y: | .0000E+00 | .3393E+04 |
| Z: | .3550E+04 | .3700E+04 |
| GRID | INTERVAL: | .4173E+03 |



INPUT -> ELEVATION LISTING (Y/N) ?

INPUT -> KEYBOARD CHAR. TO CONTINUE

*Figure 10.*-- "Show The Map To Date" Display For Random Data.

```
XXXXXXXXXXXXXX
X            X
X  DIGITIZE  X
X POINT DATA X
X            X
XXXXXXXXXXXXXX

XX INITIALIZATION XX
INPUT -> FILE NAME ? TEMP 3
INPUT -> CARTRIDGE NUMBER ? 2
INPUT -> JOB NAME (UP TO 20 CHAR.'S) ? MOONEY, TEST 7/79
INPUT -> SYMBOL TABLE NAME ? TEMP 4
INPUT -> CARTRIDGE NUMBER ? 2
INPUT -> SCALE FACTOR OF MAP ? 400
INPUT -> MINIMUM X AND Y VALUES OF MAP ? 00
```

*Figure 11.* -- Point Data Initialization Queries.

The symbol table name expected is again a legal RTE III file name. This file, if it exists, contains digitized symbols. These symbols may also be digitized as part of the point data entry process. A symbol is associated with each point as it is entered. These symbols represent broad point data categories. Following specification of the symbol file name, the cartridge number on which this file resides must also be entered. Again, this will usually be the user's cartridge number.

Next, the user is asked to enter the scale factor of the map. Appropriate values will vary with maps but the units are in map units per inch. Hence a mile per inch scale would be entered as one mile per unit. The final question asks the user to specify minimum X and Y values of the map. Again, this simply locates the origin of the map and is used to determine the location of the points which are digitized relative to that origin.

Following entry of the location of the origin the screen will be cleared and the user will be asked to turn, to digitize lower left hand, lower right hand, and upper edge points for the map. In response to each of these questions the user will press the pen or digitizing cursor once at the appropriate location. These three points are used to orient the map relative to the digitizing tablet surface.

Once this orientation has been accomplished, the user will be presented with a point data operations menu. This menu, shown in Figure 12 allows the user to add points to the map, draw the map to date including all symbols, or some symbols, create or edit the symbol table, purge the file currently being built, or terminate the point data digitization process.

If a general point data category is to be added or modified, the user will be presented with a menu shown in Figure 13. He may create a new identification symbol, display any of the existing symbols, display symbols in the table; or he may output the symbol table, where the ymbol table is the equivalent of asking for the name of the file, which was specified initially. This file contains previously digitized symbols, currently available.

Should the user wish to enter a new symbol the screen will be cleared and two input requests will be presented to him following selection of option 1. The machine first asks what symbol number he wishes to enter. Should the user not know numbers of existing symbols at this point he may always enter a 1. Software for adding symbols to the table will not allow him to duplicate existing symbols. Hence, entering a 1 will guarantee checks by the program. The second response which the user must provide is an identification for the symbol, or point data category. Next, if he specified a symbol number which already exists in the file he will be asked if he wishes to move the symbol to a different location in the file, replace the existing symbol in the file with a new one, or not add the new symbol to the table.

When a satisfactory number for the symbol/category has been found, the user must define an area on the tablet for digitizing the "master" symbol. This is oriented in a manner similar to the map itself and must be separate from the map area and is only used to describe the configura-

```
XXXXXXXXXXXXXX
X            X
X POINT DATA X
X   OPTIONS  X
X            X
XXXXXXXXXXXXXX

1 -> ADD A SYMBOL TO THE MAP
2 -> DRAW THE MAP TO DATE
3 -> CREATE / EDIT THE SYMBOL FILE
4 -> PURGE THE FILE CURRENTLY BEING BUILT
0 -> TERMINATE
 INPUT -> SELECT OPTION ? 3
```

*Figure 12.*-- Point Data Digitizing Options Menu.

```
XXXXXXXXXXXXXXXX
X              X
X USER OPTIONS X
X              X
XXXXXXXXXXXXXXXX

1 -> ENTER A NEW SYMBOL
2 -> DISPLAY A SYMBOL
3 -> DISPLAY THE WHOLE TABLE
4 -> OUTPUT THE SYMBOL TABLE NAME
5 -> PURGE THE TABLE
Ø -> TERMINATE RETURN TO POINT DATE MENU
INPUT -> OPTION NUMBER ?
```

*Figure 13.*-- Map Symbol Manipulation Menu.

tion of the symbol. Once the symbol area has been defined, the user will again be presented with some operating instructions which allow commands to be entered via the keyboard to terminate digitizing of the symbol and return to the symbol manipulation menu or abandon the symbol and return to the more general point data option menu.

The symbols which are digitized will be displayed on the screen as they are digitized in screen or tablet coordinates and be a maximum of ten points long. Hence, the user must keep his symbols fairly simple in design. Following digitization of the symbol itself, the user will be asked whether or not he wishes to display it. An answer of "yes" (Y) to this question will result in a full sized drawing symbol on the Tektronix CRT. Following a "no" answer or symbol display (N), one merely strikes any keyboard letter to continue the operation through presentation of the symbol manipulation menu. This interaction is similar to that resulting from selecting of 2 in the symbol manipulation menu-display of symbol. Here the user is asked for a symbol number which will be displayed and then again must enter any keyboard character to continue.

Option 3 on the symbol manipulation menu will result in sequential display of all symbols together with their identifiers, five at a time on the screen. At the end of each display of five symbols the user must answer yes or no (Y or N) to indicate whether he wishes to continue displaying symbols until the end of the symbol table is reached. Option 4 on the symbol manipulation menu results in a very simple output of the current symbol file name with a keyboard character to continue and return to the same menu.

Should the user select option 1 on the point data menu (see Figure 12), he must then input a symbol number following which the program will output the identification, ask the user for a yes-no response as to whether this symbol is correct, and then request a 20 character individual point identification string. This identification string identifies a particular instance of a symbol or a category of point data in the file. Following the identification of this particular symbol the user will digitize its board at the location on the map by placing the cursor or the digitizing pen on a digitizing board at the location for that point. The user will then be asked if this location and symbol are all right. If they are (a Y response is entered), he will return to the point data menu (Figure 12).

Option 2 on this menu results in a display of subsets of points and symbols entered. If this option is elected, the user must respond to a question to show all symbols. If a yes (Y) answer is entered here, he will next be asked to locate with the cursors the area for which all of the symbols should be shown. Following display of the symbols in this area he will be asked whether or not he wishes a line printer listing of all of the symbols and here he must respond with a yes or no (Y or N once again). The line printing listing itself consists of X, Y locations for all symbols together with their general category (symbol) identifier and individual or instance, identifiers. Also included are maximum/minimum values for the X and Y locations.

Under this option, and elevations should the user not wish to specify all symbols for display, he may specify one at a time symbols to be displayed by number as well as the areas for which the symbol should be displayed. That is, each symbol selected for display on the map may have its own area over which it should be displayed. The area for several symbols which will be displayed may or may not overlap, etc. Similar to the case where all symbols are displayed simultaneously, following specification of individual symbols and their display areas the user is asked whether or not he wishes a line printer listing of all the symbols used.

After responding to the LP listing option, the screen is cleared and symbols are located on a blank map. At the end of each drawing of subsets of symbols or total symbol sets, the user is asked whether he wants to create another drawing or not. By entering an affirmative (Y) response to this question, user may return to the subset definition interaction (Figure 14) and create an entirely different display.

## COREHOLE DATA ANALYSIS

(Invoked by option 2, data entry menu: see Figure 2)

Before user elects option 2 on data entry-review option menu, separate files containing drilling results must be available. These files, one for each drill hole, must be in an internal binary format. User is referred to program documentation section, Volume III, for a description of format of records in this file and associated construction procedures.

Assuming the above steps accomplished, Figure 15 will be given on the screen. User may elect to perform cross-section analysis or correlation type analysis based on parameter values. For cross-section analysis, user will be interested in constructing vertical cross-sections, possibly showing toxic zones of a particular parameter. In the second case, boundaries identifying zones or beds will be identified interactively by user. These beds will then be correlated between individual coreholes under complete user control. Procedures follow.

### CROSS-SECTION ANALYSIS

(Invoked by option 1, corehole analysis option menu: see Figure 15)

First, user is queried for a parameter I.D., which consists of an alphanumeric character string identifying a particular parameter available from corehole analysis and stored in the raw data files.

Second, user must input number of coreholes desired for analysis (currently $\leq 10$), then specify a range of X and Y values. The X and Y ranges locate coreholes relative to the origin of a map, which may or may not exist in the computer.

```
JOBNAME : MOONEY, TEST 7/79
INPUT -> SHOW ALL SYMBOLS (Y/N) ?  N
XX YOU MAY SPECIFY UP TO 10 SYMBOLS XX
       ( INPUT OF 0 TO TERMINATE )
INPUT -> SYMBOL NUMBER ? 1
INPUT -> SPECIFY AREA FOR THE SYMBOL ? Y
CURSORS -> SPECIFY LOWER LEFT HAND CORNER OF AREA
CURSORS -> SPECIFY UPPER RIGHT HAND CORNER OF AREA
INPUT -> SYMBOL NUMBER ? 0
INPUT -> LP LISTING OF ALL SYMBOLS USED (Y/N) ? Y
```

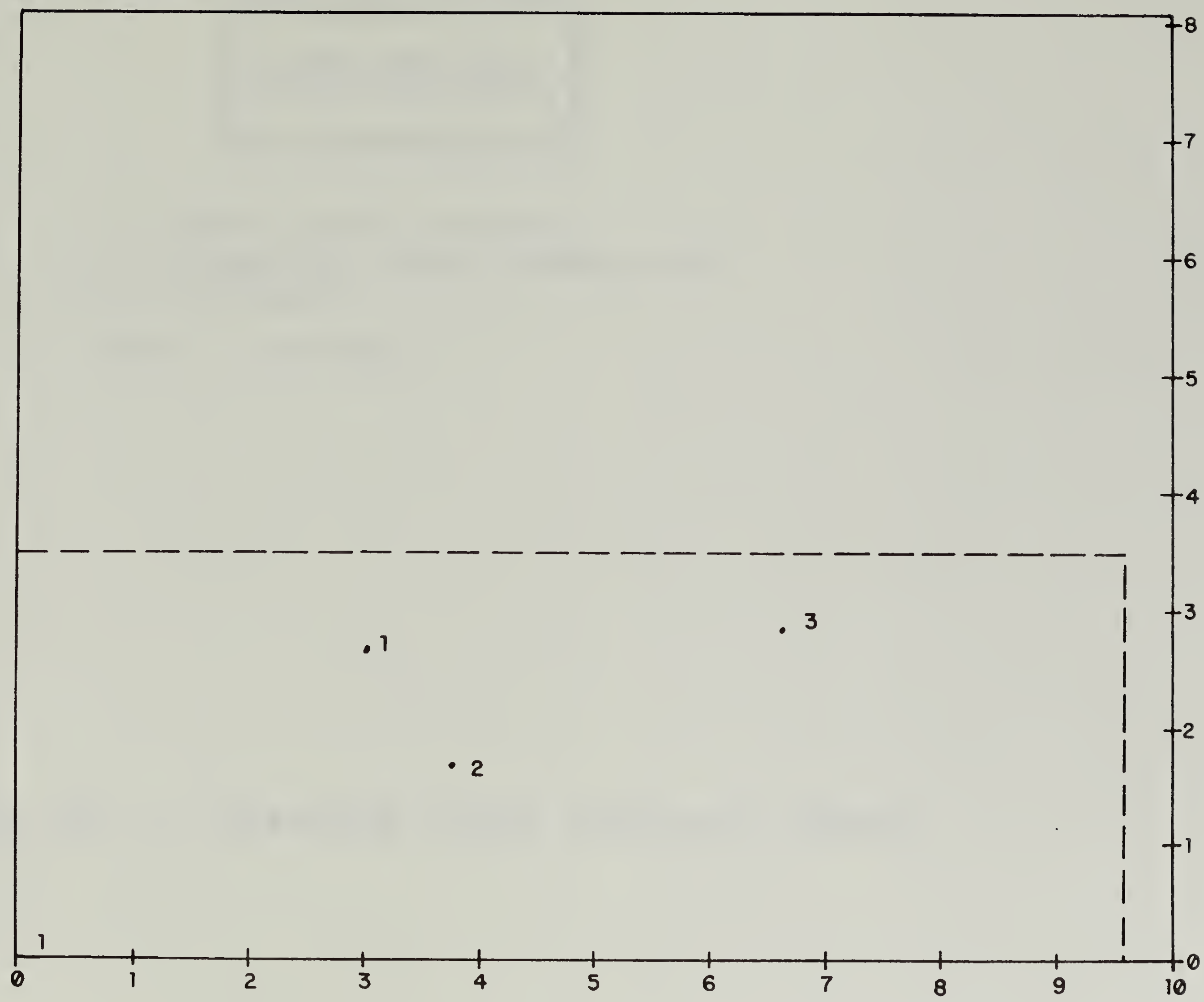



*Figure 14.*-- "Show the Map to Date" Display for Point Data.

```
XXXXXXXXXXXXXXXXXXXX
X                  X
X  CORE ANALYSIS   X
X OPTION SELECTION X
X                  X
XXXXXXXXXXXXXXXXXXXX

1 -> CROSS SECTION ANALYSIS
2 -> PARAMETER BASED CORRELATION
Ø -> TERMINATE

INPUT -> OPTION ?
```

*Figure 15.*—— Corehole Data Analysis Menu.

Third, user decides whether to use locations associated with coreholes in the file or enter arbitrary locations relative to ranges of X and Y's previously entered by cursors. A proper response is "1" or "2" followed by carriage return. If #2 is selected, the screen will be cleared, an outlined box with X-Y ranges appears, and cursors will be presented on the screen. User should position the cursors and strike a keyboard character to locate each corehole on the bounded area shown.

After locating all coreholes with cursors or arbitrary selection, answer query to input file names for each corehole (as mentioned earlier these files must have been compatible data format). Conclude specifications by identifying an output file name. Figure 16 shows typical specifications for cross-section analysis.

Since the file output by this program is in alphanumeric X-Y-Z format, the question asks user to specify an ASCII input file name. This terminology is used because this file may be used as input for grid construction. The grid constructed from this file allows user to view coreholes projected along a vertical plane and to see variations in values of selected parameter on this plane. To accomplish this, select the grid construction option on the Data Entry Review menu followed by contour display.

In addition to the creation of an XYZ data file in the interval format, the program will also output on the line printer a summary of the analysis performed. Since any grid construction which follows requires an awareness of the file parameters, save the line printer information. An example is shown in Figure 17. For the purpose of creating a file, the "scaled X" coordinates are used as random "X" values, whereas sampling interval elevations are used as "Y" values and parameter values themselves are used as "Z" values.

PARAMETER BASED CORRELATION
(Invoked by option 2, core analysis selection menu: See Figure 15)

First, the user is queried for an alphanumeric parameter key or identifier, which must be compatible with those entered in original raw corehole data format files.

Second, the user must input a range of planar location coordinates, then specify a file name for the first raw corehole data file to be used in the correlation process. Typical responses are shown in Figure 18.

Third, after specifying all required data, interaction begins, allowing user to identify zone boundaries (beds) of critical values for parameter selected. Sepcify critical values to identify beds with three options:

1. use cursors on the screen
2. input a numerical value through keyboard
3. do not change existing critical values (relevant if there is a state mandated critical value for parameter, or a critical value identified for a previous corehole).

```
XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
X                             X
X  CROSS SECTION EVALUATION   X
X                             X
XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX


INPUT PARAMETER ID -> K


INPUT NUMBER OF HOLES -> 6


INPUT X RANGE (XMIN,XMAX) ->468000,482000
INPUT Y RANGE (YMIN,YMAX) -> 1055000,1067000


1. USE X,Y COORDINATES FROM DATA FILE - OR
2. LOCATE X,Y ON GRAPH WITH CURSORS
   (TYPE 1 OR 2) ->

INPUT FILE NAME ->#RAW32
INPUT FILE NAME ->#RAW20
INPUT FILE NAME ->#RAW29
INPUT FILE NAME ->#RAW31
INPUT FILE NAME ->#RAW35
INPUT FILE NAME ->#RAW37

INPUT THE ASCII  INPUT FILE NAME ->TEMP1
```

*Figure 16.*-- Cross-Section Specifications.

```
TRANSFORMATION OF SELECTED TESTHOLES TO A STRAIGHT LINE
-------------------------------------------------------

USER INPUT:

   INITIAL ORIGIN - (XMIN,XMAX) ...                      (468000.00   1055000.00)
   NUMBER OF COREHOLES ON THE LINE  ...                                        6

   INPUT FILES ARE:          #RAW32
                             #RAW20
                             #RAW29
                             #RAW31
                             #RAW35
                             #RAW37

   CALCULATED ORIGIN - (XO,YO)  ...                      (468000.00   1062764.50)
   OUTERMOST EXTENSION OF LINE - (X1,Y1)  ...            (482000.00   1060496.25)

   NAME OF ASCII INPUT FILE CREATED  ...                                  TEMP1

 INTERNAL CALCULATIONS:
                                                                            376
   NUMBER OF POINTS ...
                                                                         10E  2
   SCALE FACTOR ...

   ORIGINAL COORDINATES          SCALED COORDINATES
       X            Y                   X
    474519.00   1060919.00            67.30
    469042.00   1066023.00             5.07
    471726.00   1055381.00            48.59
    474475.00   1066082.00            58.61
    479844.00   1066082.00           111.61
    479833.00   1055387.00           128.61
```

*Figure 17.*-- Cross-Section Line Printer Summary.

```
XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX
X                                             X
X            CORE HOLE DATA DISPLAY           X
X                 CORRELATION                 X
X                                             X
XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX


  INPUT THE PARAMETER KEY -> K


  INPUT RANGE OF THE AREA -> -
  TYPE XMIN,XMAX -> 468000,482000
  TYPE YMIN,YMAX -> 1055000,1067000


  INPUT THE TEST HOLE -> #RAW32
```

*Figure 18.*-- Inquiries for Correlation of Core Hole Data.

Further interaction, appearing in the upper left hand corner of the screen, asks user to mark critical values with the cursor or enter alphanumeric values if either a one or two is entered. If cursors are selected, the value is entered by positioning the cursor and striking any key.

Finally, once a critical value has been accepted by user for boundary identification, the computer marks each elevation in that corehole where the critical value is crossed in either an increasing or decreasing direction. These elevations are marked with dashed lines that extend past the end of the flag for a parameter.

After the boundaries are marked by computer, a query asks user to mark top and bottom boundaries in pairs with cursors. First, position the cursor to mark the top boundary. Strike any key on keyboard and an asterisk will locate top boundary. Similarly, locate bottom boundary of bed. When done, the computer will automatically position a beam between boundaries and wait for user to type a label for the bed. This label may have up to four alphanumeric characters and names the boundary data files. After the first corehole has been analyzed in this way and a "D" typed, indicating that user has labeled all beds (identifying boundaries for critical values), the screen will be cleared and the process repeated for a new corehole file.

After the screen is cleared, the corehole just processed will be displayed on the left, lower side of screen and user must input a file name containing data for the next corehole to be analyzed. When entered, a parameter "histogram" for the new corehole will be drawn on the lower right hand side, and user is given options for identifying critical values as before. Interaction from this point on is identical to the first corehole except all queries and responses apply to display at lower right hand corner of screen. Figure 19 shows labeling process where bed "BDA" has been identified in both holes shown.

Each corehole desired is analyzed in succession in this manner. The corehole previously analyzed shifts to lower left corner and corehole under analysis appears in lower right corner until finished. For completion, enter blank file name in response to a test hole file request. Now, the computer outputs a table to line printer summarizing the session for user. This output should be saved since it may be needed later to generate uniform grid files, which in turn are subsequently used to create a number of different displays showing results of corehole analysis (Data Entry Review options 3-10, Figure 2).

## CONSTRUCTION OF RAW DATA FILES FOR COREHOLE ANALYSIS

### Example Applied to Thunder Basin Data

The data used as test data for these routines is a set of corehole samples made by Dan Youngberg. The original data files had to be converted from type 3 to type 2 binary files. This conversion was done by program BUILD. The program INPT uses the random access utility routines to set up a binary keyed file containing the names of the parameters that

```
INPUT THE TEST HOLE -> 3#RAW35
DO YOU WISH TO DEFINE A NEW CRITICAL VALUE:
1. USING THE CURSORS?
2. BY INPUTING A NUMERIC VALUE FOR R FLAG?
3. NO NEW CRITICAL VALUE DESIRED.
(INPUT '1', '2', OR '3') -> 3
MARK THE BOUNDARIES WITH CURSOR -
INPUT A LABEL-TYPE 'D' WHEN DONE.
```

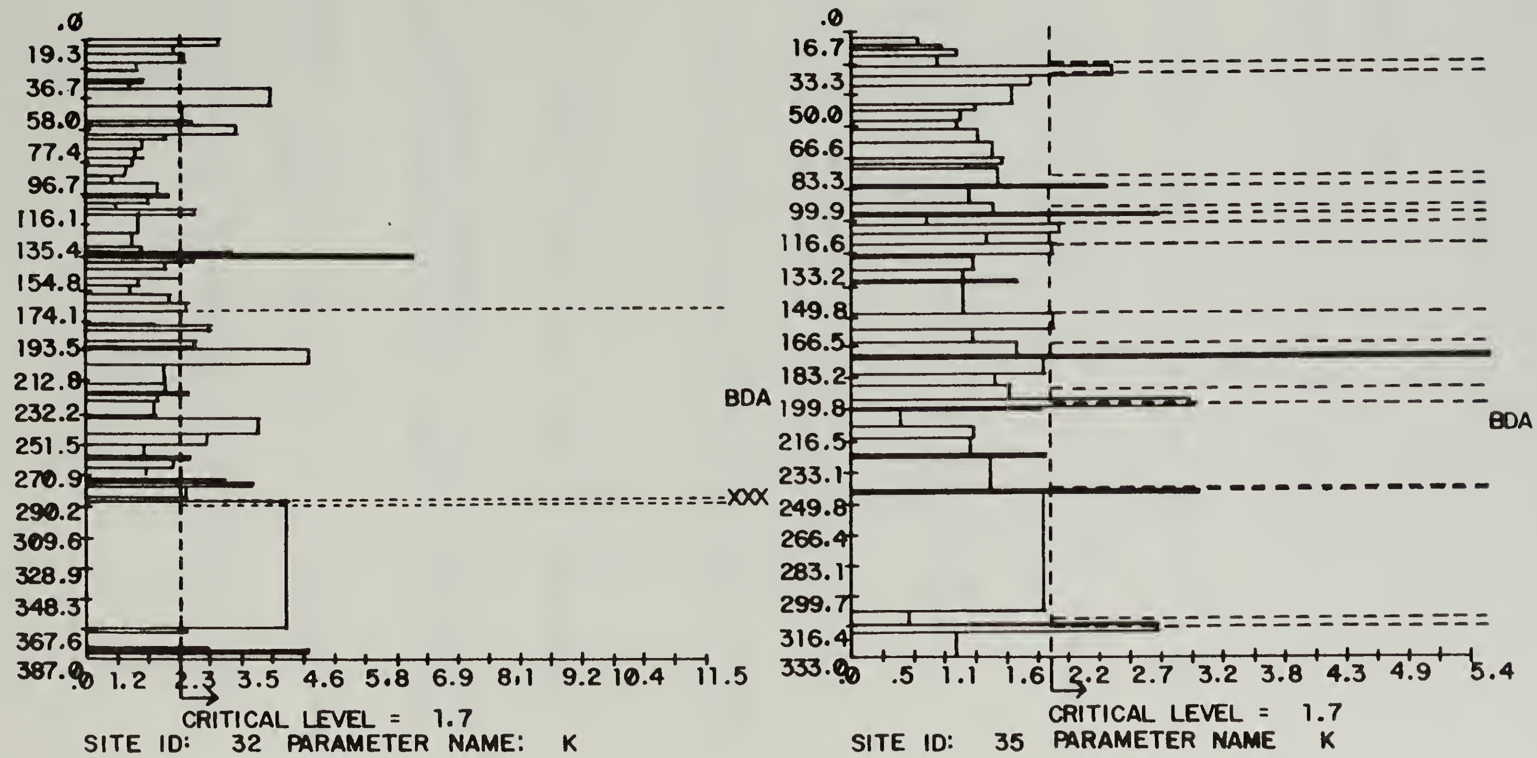



*Figure 19.*-- Parameter Based Correlation Display.

were tested as the keys. The user must name the keyed file, specify the sizes of the data record and the header records, and specify the number of parameter keys and the number of sampling intervals in the data file. The format of the binary files is set up in this routine and the data is read from the type 2 file and written in a new format into the binary file. The format of the file is all arbitrary and subject to the user's needs. At this point the geologist's data is now ready to be used by the correlation and cross-section analysis routines.

## CONSTRUCTION PROCESS FOR EXAMPLE DATA

1. Run Program BUILD to Convert from Type 3 Files to Type 2.

   Interaction

   A. INPUT NAME OF THE COREHOLE FILE? This is the name of type 3 file.

   B. INPUT THE NAME OF THE DESTINATION FILE? This is the name of file where you wish the converted data to be placed.

   C. INPUT THE NUMBER OF LINES TO BE READ? This is the total number of records in the type 3 file. In this example, 330 would be used (Figure 20).

   D. NUMBER OF INTERVALS? In our example, 330 would again be used, since each record contains a unique elevation.

2. Run Program INPUT to Convert the Type 2 Data File to a Keyed Binary File.

   Interaction

   A. INPUT THE NAME OF THE INPUT FILE? This would be the name of the type 2 file.

   B. INPUT THE NUMBER OF SAMPLING INTERVALS? In our example, 330 would again be used, since this is the number of different elevations used.

   C. INPUT X, Y COORDINATES? This is the location, in geographical coordinates, of our corehole.

   D. INPUT THE NAME OF THE FILE TO BE WRITTEN INTO? This is the name of the keyed binary file.

| RECORD | ELEVATION | VALUES FOR PARAMETERS |
|---|---|---|
| 1 | 1010 | 35, ƀ1.0,$^{2}$ƀ0.0,$^{3}$ƀ5.5 |
| 2 | 1011 | ƀ7.0, ƀ0.35, ƀ0.5, 60.8, ƀ4 |
| • | | |
| • | | |
| • | | |
| 330 | 1555 | 6, 63, ƀƀ7, 30, 19 |

*Figure 20.*-- Example of Type 3 File Used by Program Build.

# UNIFORM GRID CONSTRUCTION

(Invoked by option 3, data entry menu: see Figure 2)

Uniform grid construction is entered by electing option 3 on the data entry and review menu of SPLAN (Figure 2).

Uniform grid construction is used to convert XYZ ASCII files to uniform grid files. These grid files are important in that most of the review options rely on grid files.

The construction of a grid file is a two step process. First the ASCII files created by an entry option must be converted to a binary file. The binary file is then used to construct the grid file. These two operations are performed by electing options from the menu shown in Figure 21 which is placed on the screen after electing a 3 on the Data Entry Review menu (Figure 2).

## BINARY FILE CONSTRUCTION

To construct a binary file an input of "1" must be selected on the grid construction option menu (Figure 21). The screen is then cleared and the user must answer four questions.

The first question asks the user to input up to twenty characters for a general file description. The second question asks the user to input the name of the ASCII file that is to be used to create a binary file. This name must be no more than 6 characters in length. The third question asks the user to input a file name for the binary file, and the fourth and last question asks the user to input the cartridge number where the binary file is to reside. This is usually the user's cartridge number. This cartridge must be mounted, otherwise an error condition will occur and this portion of SPLAN will be aborted.

Any duplicate data records will be displayed on the line printer. Any other errors will also be displayed on the line printer.

## GRID FILE CONSTRUCTION

The second part of the two step grid file construction process is to create a grid file from a binary file. To construct a grid file, option 2 on the file construction menu (Figure 21) must be selected. The screen is then cleared and the user is asked to respond to a number of questions.

The user is first asked the name of the binary (XYZ) file to be used. The user is then asked to input the appropriate Z value number to be used. Each X, Y planar coordinate pair may have between one and five different "Z" values associated with it, although files created through digitizing or corehole analysis will have only one.

```
XXXXXXXXXXXXXXXXXXXXX
X                   X
X FILE CONSTRUCTION X
X OPTION   SELECTION X
X                   X
XXXXXXXXXXXXXXXXXXXXX

1 -> CONSTRUCT A BINARY FILE
2 -> CONSTRUCT A GRID FROM A BINARY FILE
0 -> TERMINATE
INPUT -> OPTION ?
```

*Figure 21.*-- File Construction Option Menu.

The user is next asked to input a grid interval to be used in constructing the grid file. This interval corresponds to the grid cell size in the map units, and must be selected in conjunction with the map size so that the number of grid cells in either direction (X or Y) is less than 50.

Following specification of the grid cell size, the user will define the total map area by setting minimum and maximum X and Y coordinates to be used from the binary file. If the user inputs all zeros the default case results where the minimum and maximum values in the binary file are used. The user then enters the total number of grid cells that will be scanned for points to approximate the interval. Reasonable values here are 10 to 20, with about 90% if experienced grid construction errors due to specification of too small a value here.

He may also choose to validate the input points. A validation forces any grid cell corners whose coordinates match original data points to the actual value.

The next information the user must provide is the name of the grid file (output) and the cartridge where this file is to reside.

The user is then asked if he wishes to set the minimum and maximum elevations. If he does, the grid file will contain only those elevations which fall between these two values. However, if the user does not set the minimum and maximum elevations, the grid file will contain all of the calculated elevations. Figure 22 illustrates typical response to grid file creative queries, as the program initiates the actual construction.

A line printer listing will be produced giving a summary of all parameters used along with calculated maximums and minimums of the X and Y's for the grid file. This listing also contains the number of X, Y, Z points used in the calculations of the grid file. Any errors detected in the creation of the grid file will also be displayed on the line printer.

Following successful grid file creation, control returns to the file construction options menu (Figure 21). If the creation of the grid file was successful a Ø should be entered and control will return back to the data entry and review options. However, if the creation of the grid file was unsuccessful, another attempt can be made by entering a two for the option input.

## GRID INTERPOLATION

(Invoked by option 4, data entry menu: See Figure 2)

Grid interpolation is option 4 of the data entry and review options of SPLAN (Figure 2). It is designed to allow the user to create a new grid file from an existing grid file. The user may change the grid interval or the minimums and maximums of the geographical coordinates.

```
NUMERICAL APPROXIMATION TO A UNIFORM GRID
INPUT -> SOURCE FILE NAME ? # TW1MB
INPUT -> APPROXIMATE Z VALUE NUMBER (1-5) ? 1
INPUT -> GRID INTERVAL ? 3
INPUT -> MAXIMUM X AND Y VALUES ? Ø, Ø
INPUT -> MINIMUM X AND Y VALUES ? Ø, Ø
INPUT -> MAXIMUM SCANNING RADIUS (# OF GRIDS) ? 1Ø
INPUT -> VALIDATE INPUT POINTS (YES / NO) ? NO
DESTINATION FILE NAME ? # TW1MG
CARTRIDGE # ? 2Ø
SET Z MIN, Z MAX (YES / NO) ? YES
INPUT Z MIN, Z MAX -> Ø,1ØØ
```

*Figure 22.*-- Typical Grid Construction Querie.

The following questions are presented to the user for response.

1. JOB NAME? This allows the user to enter up to 20 alphanumeric characters which are used to identify the new grid file.

2. SOURCE FILE? The name of the existing grid file should be entered here.

3. DESTINATION FILE? The user now enters grid file.

4. MINIMUM AND MAXIMUM X AND Y VALUES? This allows the user to redefine the extent of the new grid file. An input of Ø defaults to the parameters of the old grid files.

5. GRID INTERVAL? The user now inputs the grid interval at which the new file is to be built.

A line printer listing is then displayed giving the parameters of the new grid file (Figure 23).

## GRID OPERATIONS

(Invoked by option 5, data entry menu: See Figure 2)

The grid operations are option 5 of the data entry and review module of SPLAN ( Figure 2). They are designed to let the user add, subtract, multiply, or divide either grid or binary files to create new files.

In the case of grid files the following questions are presented for user response.

1. SOURCE FILE NAME? The user may input from one to three grid files, one at a time. This process is terminated when the user enters a blank followed by a carriage return. In the case where only one grid file is used, the user is asked to input a value which will be used as a constant operator to create the new grid file.

2. THE TYPE OF OPERATION? These operations include addition, subtraction, multiplication, or division. In the case of one grid file the constant operation is used to operate on each elevation. In the case of two grid files the operation is used by elevation to create the new grid file. In the case of three grid files the first operation is performed between the first two grid files entered to give an intermediate file. The second operation is then performed between the intermediate file and the third grid file entered.

```
G R I D   I N T E R P O L A T I O N                    CHECK DEFAULT          PAGE 1

            THE INPUT GRID FILE IS READ FROM FORTRAN LOGICAL UNIT NUMBER 31
            THE OUTPUT GRID FILE IS RECORDED ON FORTRAL LOGICAL UNIT NUMBER 32
            THE MINIMUM X VALUE FOR THE OUTPUT GRID FILE IS   .2500000E+00
            THE MINIMUM Y VALUE FOR THE OUTPUT GRID FILE IS   .7980000E+02
            THE MAXIMUM X VALUE FOR THE OUTPUT GRID FILE IS   .1502500E+03
            THE MAXIMUM Y VALUE FOR THE OUTPUT GRID FILE IS   .1218000E+03
            THE GRID INTERVAL FOR THE OUTPUT GRID FILE IS   .3000000E+01
```

*Figure 23.*-- Sample Grid Interpolation Line Printer Summary.

3. DESTINATION FILE NAME AND CARTRIDGE NUMBER? The user then enters a name for the new grid file and the cartridge number where that file is to reside.

4. JOB NAME? This is up to twenty alphanumeric characters which are used to describe the new file.

5. In the case of two or more grid files the user is asked to specify the grid coordinates for the new file. An input of Ø causes the default case, where the grid coordinates for the new file are copied from the first grid file entered. Caution should be used, so that all the grid files contain the grid interval specified, or defaulted to.

In the case where a binary file is used the following questions are presented to user for response:

1. SOURCE FILE NAME? This is the name of the binary file to be used.

2. Z OPERAND? Every binary file contains between one and five elevations for each geographical coordinate pair. The user may select up to three elevations to be operated on. This process is terminated by entering a space followed by a carriage return.

3. CONSTANT OPERATOR? If the user has input only one elevation number, the constant operator will be used for all operations.

4. WHICH Z SHOULD RESULT BE PLACED IN? The user has the option of putting the results in any of the five available elevation locations of the new binary file.

5. OPERATION? The operations include addition, subtraction, multiplication, or division. In the case of one Z value, the operation will be performed between the two elevations for each geographical coordinate. In the case of three Z values the first operation will be performed between the first two elevations to give an intermediate elevation. Then the second operation will be performed between the intermediate results and the third Z values.

6. DESTINATION FILE NAME AND CARTRIDGE NUMBER? The user is then asked to name the created binary file and to input the cartridge number of where this new file is to reside.

7. JOB NAME? The user may then enter up to 20 alphanumeric characters to describe this file.

A line printer listing is then displayed. This contains the minimums and maximums for the geographical coordinates of the newly created files (Figure 24).

```
D A T A   F I L E   M A N I P U L A T I O N                              THREE GRID FILES

   DESCRIPTION OF DATA FILES :
                                                  NAME         UNIT NUMBER

                     FIRST INPUT FILE             #PLT61           33

                     SECOND INPUT FILE            #PLT62           34

                     THIRD INPUT FILE             #PLT63           35

                     OUTPUT FILE                  #TEST            36

   OUTPUT FILE  PARAMETERS
                          FILE TYPE                  GRID

                          MINIMUM X VALUE         1.0000000E+02

                          MINIMUM Y VALUE         1.0000000E+02

                          MAXIMUM X VALUE          .2700000E+04

                          MAXIMUM Y VALUE          .2700000E+04

                          MINIMUM Z VALUE          .1025200E+05

                          MAXIMUM Z VALUE          .1067300E+05

                          GRID INTERVAL           1.0000000E+02

   OPERATION PARAMETERS:
                          FIRST OPERATION IS ADDITION
```

*Figure 24.*-- Sample Grid Operations Line Printer Summary.

## GRID SECTION DISPLAY/EDITING

(Invoked by option 6, data entry menu: See Figure 2)

Grid section display/editing is option 6 of the data entry and review option of SPLAN (Figure 2). It is designed to allow the user to edit grid files either row by row, or column by column.

The first question presented to the user for response is "Source File?" The user may input up to three different grid file names. This process is terminated by entering a blank followed by a carriage return.

The screen is then cleared and the parameters for each file are presented. The parameters for each file should be the same. The user may change the header name of any of the grid files if he wishes (Figure 25). The user is then asked whether he wishes to display the files by rows or by columns.

The first row or column of each file is then displayed to the user (Figure 26). The following options are also presented to the user:

D# -- The user may display the elevation of any point shown. This is done by positioning the cursors at the point and by entering the number of the file (1-3) this point occurs on. The surface number, the point number and the elevation are then displayed for the user.

C# -- The user may change the elevation for any point on any given line. This is accomplished by positioning the cursors to the new elevation for the point and by entering the file number (1-3). The surface number, the point number, the old elevation and the new elevation are now displayed.

R -- The user may redraw this section.

P -- The user can plot this section on the plotter.

Q -- The user can proceed to the next row or column. If he was at row 1 then row 2 would be displayed.

J# -- The user can move to a new row or column, or change from rows to columns and vice versa. This is accomplished by entering a "J". The user can then pick between rows and columns. Then he should specify which row or column number he wishes to move to.

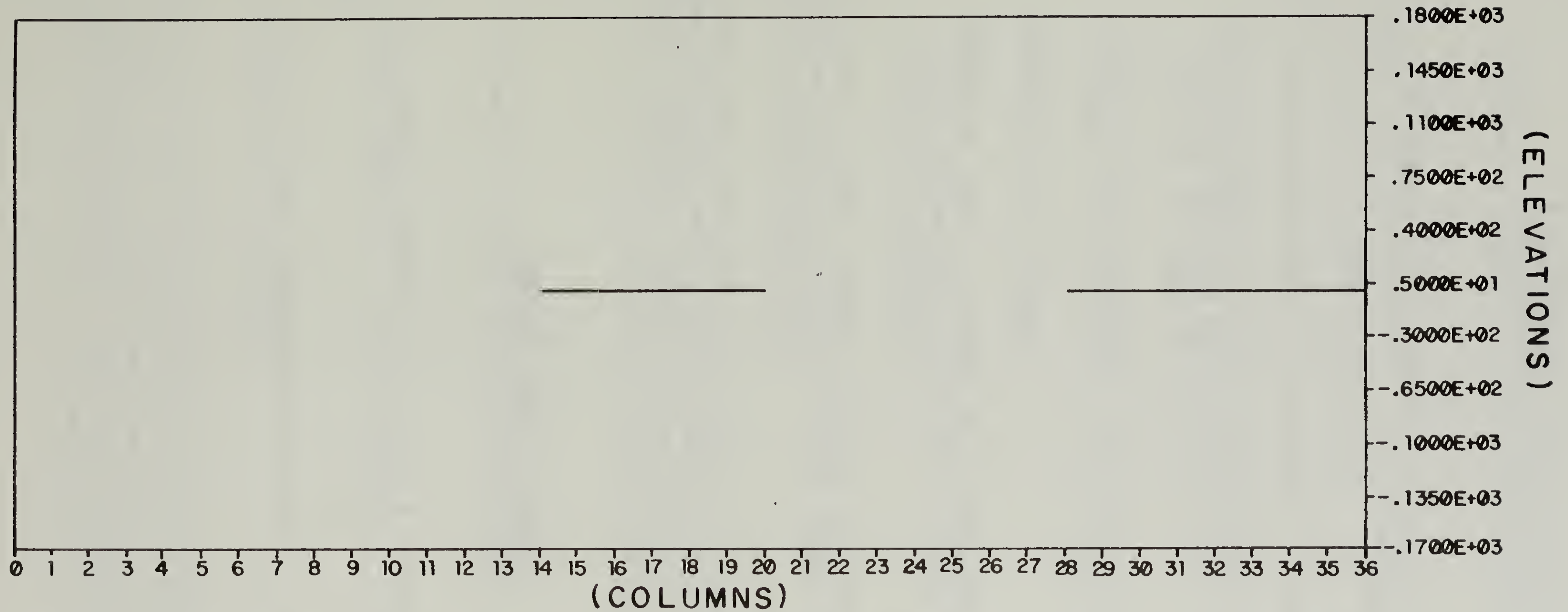
T -- The user can terminate the editing process and create a new grid file from the edited grid file. In which case the user would be asked to enter a name for the new grid file.

A -- The user can abort the editing process. He would then return to the data entry and review options.

```
XXXXXXXXXXXXXXXXXXXXXXXXX
X                       X
X    DATA PREPARATION   X
X GRID SECTION DISPLAYS X
X                       X
XXXXXXXXXXXXXXXXXXXXXXXXX

SOURCE FILE # 1 PARAMETERS:

   MINIMUM X VALUE:    .0000E + 00
   MINIMUM Y VALUE:    .0000E + 00
   MAXIMUM X VALUE:    .9000E + 03
   MAXIMUM Y VALUE:    .9000E + 03
   GRID INTERVAL   :   .2500E + 02
   MINIMUM Z VALUE:    .0000E + 00
   MAXIMUM Z VALUE:   1.0000E + 01

HEADER NAME: F&G ELK - #A0.72

CHANGE HEADER NAME (Y/N) ? N

SOURCE FILE #2 PARAMETERS:

   MINIMUM X VALUE:    .0000E + 00
   MINIMUM Y VALUE:    .0000E + 00
   MAXIMUM X VALUE:    .9000E + 03
   MAXIMUM Y VALUE:    .9000E + 03
   GRID INTERVAL   :   .2500E + 02
   MINIMUM Z VALUE:    .0000E + 00
   MAXIMUM Z VALUE:   1.0000E + 00

HEADER NAME: F&G ELK - #A0.73

CHANGE HEADER NAME (Y/N) ? N

DO YOU WANT TO EDIT GRID BY ROWS OR COLUMNS (R/C) ? R
```

*Figure 25.*-- Parameter Displays for Grid Section Displays / Editing.

ROW: 1 F8G ELK - #A0.72
F8G ELK - #A0.73




CURSOR CONTROL OPTIONS: SURFACE POINT VALUE OTHER MESSAGES
D# -> DISPLAY POINT VALUE ON SURFACE #
C# -> CHANGE POINT VALUE ON SURFACE #
R -> REDRAW THIS SECTION
P -> DRAW ON PLOTTER
Q -> QUIT THIS SECTION – DISPLAY NEXT
J# -> JUMP TO NEW ROW (#-R) OR COLUMN (#-C)
T -> TERMINATE EDITING – CREATE NEW FILE
A -> ABORT – NO NEW FILE

*Figure 26.*-- Grid Section Display / Editing Options.

## 3 DIMENSIONAL SECTION DISPLAYS

(Invoked by option 7, data entry menu: See Figure 2)

Three dimensional grid displays are option 7 of the data entry and review module of SPLAN (Figure 2). It is designed to allow the user to display, by rows or columns, a grid file.

The following questions are presented for user response:

1. GRID FILE NAME? The user should enter the name of the grid file for which he wants the displays. This grid file must exist at the time of the call.

2. DISPLAY BY ROW OR COLUMN? The user has the option of displaying the grid file by rows or by columns.

3. STARTING ROW OR COLUMN?

4. NUMBER OF ROWS OR COLUMNS TO BE DISPLAYED? This number should not be larger than about five. Number larger than this may not fit on the screen.

The screen is then cleared and three dimensional cross-sections of each specified section are drawn. Useful header information is also displayed on the screen (Figure 27).

The user can then display more rows or columns at his discretion. If he decides to display more cross-sections questions two through four are presented for response. However, if he chooses not to display more cross-sections the data entry and review options are presented again.

## CONTOUR (GRID) DISPLAYS

(Invoked by option 8, data entry menu: See Figure 2)

The grid contour displays are option 8 of the data entry and review module of SPLAN (Figure 2). It is designed to reproduce grid files in a map format.

The screen is then cleared and the user is asked to input the name of the grid file to be displayed.

The screen is cleared once again and the user is asked to input the interval at which the contours are to be drawn. This value should be small enough so as to show the major contour lines and large enough to avoid cluttering the map. This can be accomplished by trial and error if the user is unfamiliar with the surface to be displayed.

```
DRAW MORE ROWS OR COLUMNS ? Y
INPUT -> DISPLAY BY ROW OR COLUMN (R/C) ? C
INPUT -> STARTING ROW (COLUMN) ? 1
INPUT -> # OF ROWS (COLUMNS) TO BE DISPLAYED ? 3
```

```
XXXXXXXXXXXXXXXXXXXX
X                  X
X DATA PREPARATION X
X   CROSS SECTION  X
X   3-D DISPLAYS   X
X                  X
XXXXXXXXXXXXXXXXXXXX
```

```
TOPOGRAPHY

DISPLAY BY:  ROW
FIRST ROW   :    1
# OF POINTS:    27
```

```
       MINIMUM       MAXIMUM
X:  1.0000E+02    .2700E+04
Y:  1.0000E+02    .2700E+04
Z:    .3460E+04    .3665E+04
INTERVAL:  1.0000E+02
```

*Figure 27.*-- Sample Three Dimensional Grid Display Output.

The screen is then cleared and a map representing the grid file is displayed (Figure 28). Header information is also displayed. The information contains the minimum and maximum elevations of the grid file. This information is useful in calculating a good contour interval.

The user is then given the option of getting a plotter copy of the map, zooming in on a portion of the map, or changing the contour interval. If the user answers no to all these questions the data entry and review module options are displayed. To zoom in on any area of the map the user simply positions the cursors at the lower left hand corner of the desired area, and then at the upper right hand corner. This area is then outlined for the user. The screen is then cleared and this area is displayed. This process then starts over again.

## 3 DIMENSIONAL DISPLAYS (GRID)

(Invoked by option 9, data entry menu: See Figure 2)

The three dimensional displays are option 9 of the data entry and review module of SPLAN (Figure 2). It is designed to allow the user to see three dimensional displays of grid files.

The following questions are presented for user response:

1. GRID FILE NAME? The user should make sure of the desired grid file existence before entering the name.

2. VIEWING POSITION? The user should first enter the number of degrees the map should be rotated about the vertical axis. A good value for this is 225 degrees. The user should then enter the number of degrees ($\emptyset$ < theta < 90) that the map should be rotated about the horizontal axis. A good working value for this seems to be 25 degrees.

3. ELEVATION FACTOR? This value is multiplied by every elevation. A value of one is a good initial value and will show the grid file exactly as it is. Higher values may be used to exaggerate the peaks and valleys in the grid file.

4. REMOVE HIDDEN LINES? A "Y" to this question will suppress the display of hidden lines if any exist from the current viewing position.

The screen is then cleared and a three dimensional view of the grid file is shown. Also displayed is some header information from the file, and the viewing position values and the elevation scale factor (Figure 30).

The user then has the option of getting a plotter copy, changing the viewing position, changing the elevation factor, or removed hidden lines. Answering "N" to all these options causes the data entry and review options

```
XXXXXXXXXXXXXXXXXXXX
X                  X
X DATA PREPARATION X
X CONTOUR DISPLAYS X
X                  X
XXXXXXXXXXXXXXXXXXXX

TOPOGRAPHY
FILE: #PLTG1

      MINIMUM      MAXIMUM
X:  1.0000E+02   .2700E+04
Y:  1.0000E+02   .2700E+04
Z:   .3460E+04   .3665E+04

GRID SIZE:  1.0000E+02
CONTOUR
INTERVAL:     .2500E+02

PLOTTER COPY (Y/N) ? N

ZOOM? INPUT-> Y/N ? N
CHANGE CONTOUR INTERVAL ?
INPUT-> Y/N ? N
```

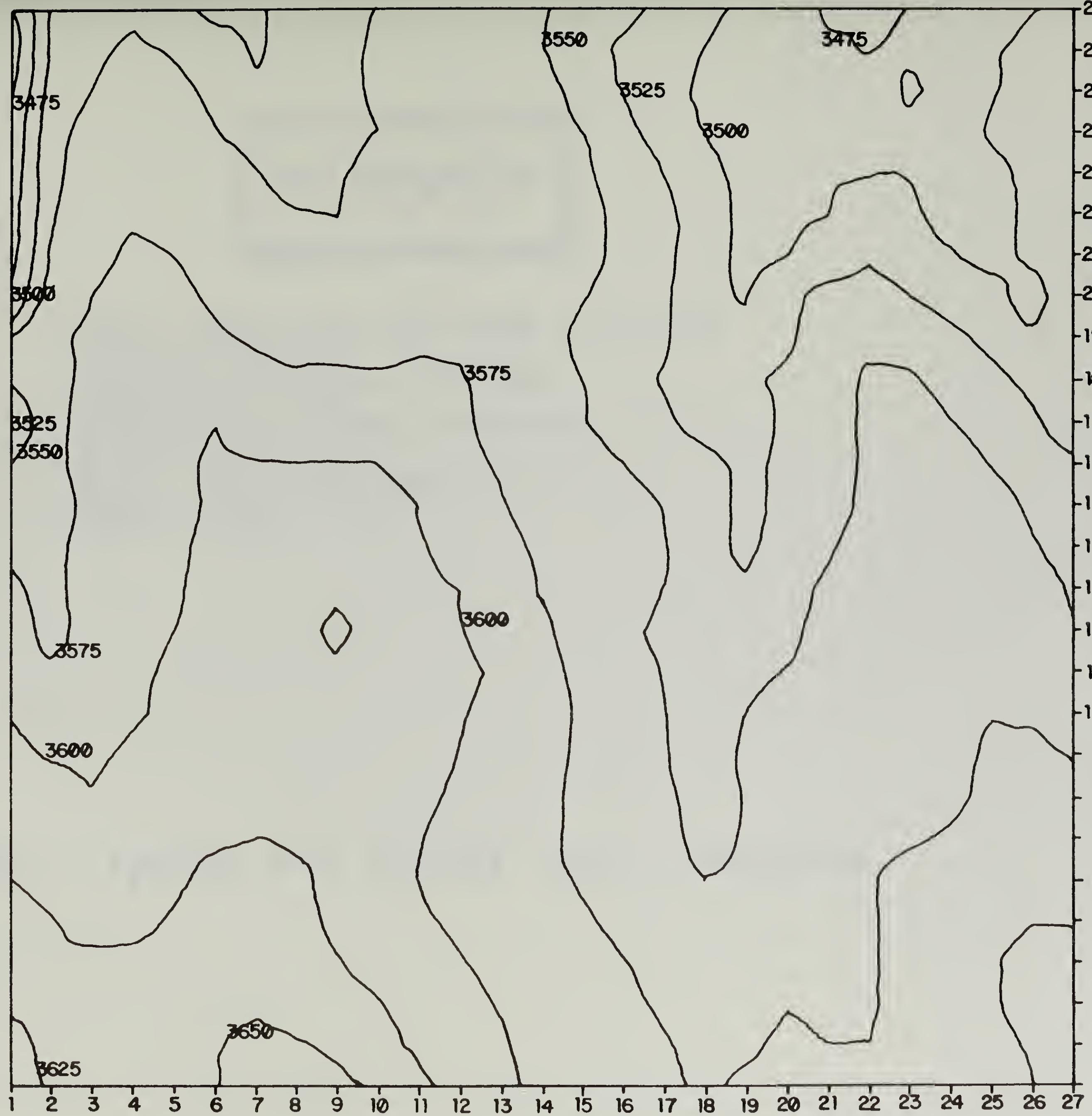



*Figure 28.*-- Typical Contour (Grid) Display.

```
XXXXXXXXXXXXXXXXXXXX
X                  X
X DATA PREPARATION X
X   3-D DISPLAYS   X
X                  X
XXXXXXXXXXXXXXXXXXXX

INPUT -> GRID DATA FILE NAME ? # PLTG4
VIEWING POSITION:
CLOCKWISE VERTICAL ROTATION
INPUT -> PHI ? 225
CLOCKWISE HORIZONTAL ROTATION
INPUT -> THETA ? 25
INPUT -> ELEVATION FACTOR ? 1
REMOVE HIDDEN LINES ?
INPUT -> Y/N ? N
```

*Figure 29.*-- Typical 3-D Display Query Responses.

```
PLOTTER COPY ? N
VIEW FROM ANOTHER POSITION ? Y
VIEWING POSITION:
CLOCKWISE VERTICAL ROTATION
INPUT -> PHI ? 25
CLOCKWISE HORIZONTAL ROTATION
INPUT -> THETA ? 225

       0 <= THETA <= 90
CLOCKWISE HORIZONTAL ROTATION
INPUT -> THETA ? 25
INPUT -> ELEVATION FACTOR ? 5
REMOVE HIDDEN LINES ?
INPUT -> Y/N ? N
```

```
XXXXXXXXXXXXXXXXXXXX
X                  X
X DATA PREPARATION X
X   3-D DISPLAYS   X
X                  X
XXXXXXXXXXXXXXXXXXXX
```

```
F&G ELK - #A0.72
FILE:  #TMPG1
PHI:      225.0
THETA:     25.0
Z SCALE FACTOR:   5.00
```

```
       MINIMUM      MAXIMUM
X:   .0000E+00    .9000E+03
Y:   .0000E+00    .9000E+03
Z:   .0000E+00   1.0000E+01
   GRID SIZE:     .2500E+02
```

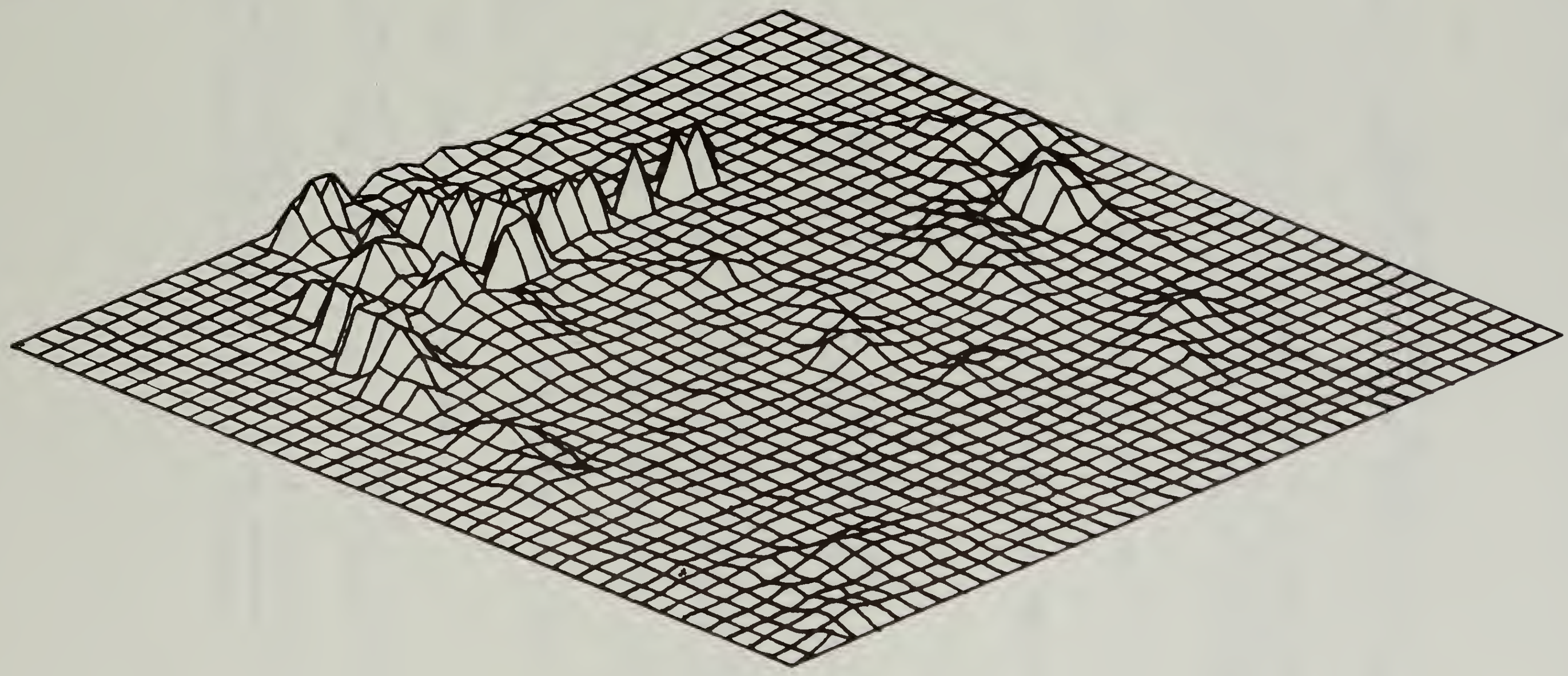


*Figure 30.* -- Example of 3-D Display.

to be displayed again. However, answering "Y" to any of the questions clears the screen and the grid file is displayed again using the new information.

## LP LISTINGS (DATA OUTPUT)

(Invoked by option 10, data entry menu: See Figure 2)

The line printer listings are option 10 of the data entry and review module options. The user can get a line printer of listing of a grid file or of a binary file. These can be useful in creating, editing or displaying grid files.

The only thing the user must input is the name of the grid file or of the binary file.

The binary or grid file header is listed along with the dump of that file.

## OVERLAY DISPLAYS (CONSTRUCTION)

(Invoked by option 11, data entry menu: See Figure 2)

The overlay displays will be option 11 of the data entry and review module options. As of the present time it has not been implemented.

It will be designed so that the user can overlay continuous data files and point data files.

As of today, the overlay option will allow the user to show digitized continuous displays.

The only input needed is the file name.

The user then sees the map. Also displayed with the map is some header information along with a key to the map (Figure 7).

The user then has the option of getting a hardcopy, zooming in on an area, or changing the contour interval. If he answers "N" to all these options the data review and edit options are displayed.

The production analysis module has been implemented, as have other programs in the SEAMPLAN system in a highly interactive environment. As such, a description of the use of the routine of the module will center primarily around a description of the required responses to the messages placed on the screen by the computer. In addition, however, several files are used to provide a default parameter values to the production analysis program, and the user must be aware of the data contained in these files. The input files utilized by production analysis are #VNADM, #VNLRS, #VNCFA, #DRAG, and #MINE. All but the #MINE file consist of alphanumeric records which, and must be presented, for successful execution of the production analysis module. The #MINE file, however, is an internally formatted binary file which is produced at various stages during the production analysis process, the two major ones being pit layout and the multiple pit, or dynamic programming, optimization activities. All output of interest to the user, including queries for information and menu input requests, are placed on the Tektronix 4014 CRT, and at various points, reports are output to the line printer.

As with other modules in which SEAMPLAN, interaction with the user through the CRT can be divided into two basic classes: 1)queries, and 2) menu selection. Responses to menu selection requests made by the computer consist entirely of entering a number from the menu following the input request line, whereas queries may request yes/no answers, alphanumeric data input, or numeric data input from the user. It is the purpose of this section of the report then, to describe the various options available to the user in the production analysis module as well as the appropriate responses to various menus and queries.

Figure 31 summarizes the major interaction points in the production analysis module. As can be seen, the interaction has been designed to be highly structured. That is, normally the sequence at each descending level of structure will consist of an initialization part followed by an option selection menu, possibly followed by further initialization or menu selection at a lower level. Figure 31 can be interpreted in the broad sense as a flow chart. Each nested block represents a lower level of interaction with the user, and upon concluding the interaction at a particular level by selection "0" on that level's menu a return is automatically indicated by this figure to the next higher level interaction (the enclosing box). The result of each menu selection is indicated in Figure 31 by numbered blocks following a response input. Each input response shows, in paranthesis, the possible responses, with each correponding to a block nested within the outer block.

The production analysis interaction begins with initialization queries. The first of these asks the user whether or not he wishes to change the value of any variables in the default of #VNADM data file.

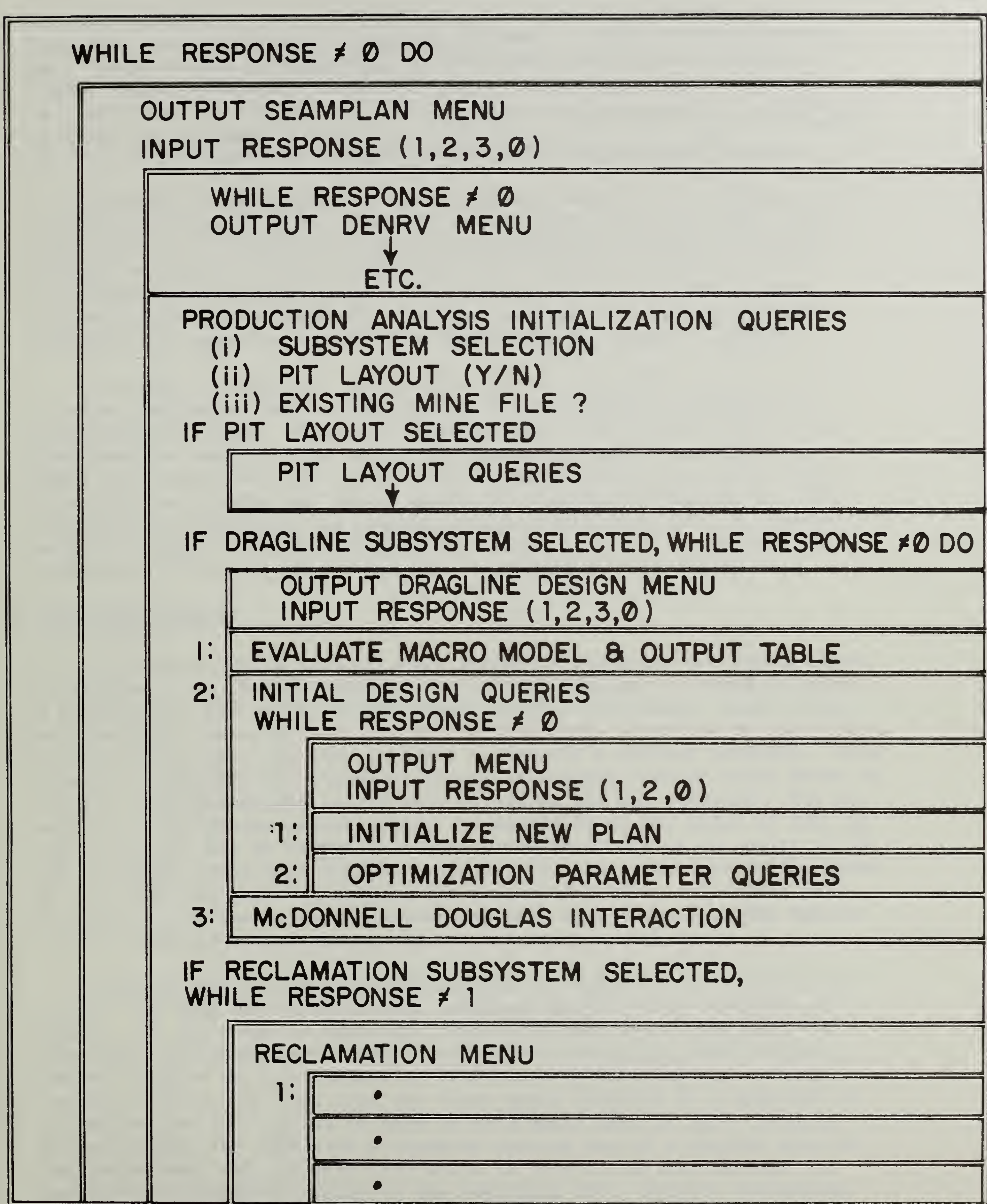



*Figure--31.* Summary of Production Analysis Use.

In order to do this, he will usually have a list of the current file before him, and any parameters which he desires to change interactively he may. This is done by responding to the change query with an answer of "yes". Next, values are changed by typing a parameter name followed by an equals sign (=) followed by the new value which he wishes to assign and striking the carriage return key. This may be done until the user enters an "*", indicating he is through changing the file parameter values.

Assuming he has typed "no" to the change request or terminated the change activity with a "*", the initiation completed in the next phase where the user is asked to specify the subsystems he wishes to analyze as well as indicate whether interactive pit layout is desired or not. With respect to the first query, the user may enter following a list of the possible subsystems which may be analyzed, a string of numbers separated by commas to indicate the subsystems he wishes to analyze.

Following response to this query, the user is asked to respond in a yes/no fashion to indicate whether or not he wishes to engage in interactive pit layout. Should he respond with a "no" answer here, he is then asked to respond in a yes/no fashion as to whether an existing #MINE file should be used to provide information about the site. Should he answer "no" to the pit layout query, or assuming pit layout has been successfully completed, the dragline design option menu will be presented next. Figure 32 illustrates typical phase 2 production analysis initialization where pit layout has been requested at this level.

## PIT LAYOUT QUERIES

The queries which lead the user through interactive pit layout occur in basically two phases. In the first phase, the user is asked to select a contour map upon which the pit layout will be performed. This is done by entering a number from a list of available maps presented on the screen. Also at this point, the user is asked to specify a contour interval. This interval represents the change in elevation between contour lines drawn on the map, and appropriate values will depend on the map selected. For example, for topography proper values are generally on the order of 100, as where isopachs may be better displayed using intervals on the order of 10, and stripping ratio maps must be drawn with contour intervals on the order of .1. Once the user has entered the contour interval, the screen will be cleared, and the selected contour map will be displayed on the Tektronix CRT, and phase 2 of the pit layout interaction will begin.

Once the map is drawn and the program is prepared for further interaction, the bell on CRT will sound, and the user is ready to begin pit layout. In all cases in this next phase, the sounding of the bell indicates that the computer is ready for further interaction with the user. Further queries may be obtained at this point by striking the carriage return (CR) key. In this case the first query obtained is a question as to whether the user wishes to zoom in on a small area or not. Zooming in can provide the user with a blown-up contour map of a smaller area on the larger map, and the area over which to zoom is defined through the use of the cross-hair cursors on the Tektronix CRT. Details concerning the method of zooming described in more detail in the section describing Data Entry and Review Module, page 29.

```
XXXXXXXXXXXXXXXXXXXXXXXXX
X                       X
X  PRODUCTION ANALYSIS  X
X    INITIALIZATION     X
X                       X
XXXXXXXXXXXXXXXXXXXXXXXXX


XXX SUBSYSTEM  SELECTION XXX

     0 -> NONE
     1 -> COAL LOAD AND HAUL
     2 -> OVERBURDEN DRILL AND BLAST
     3 -> DRAGLINE
     4 -> GENERAL ADMINISTRATIVE
     5 -> RECLAMATION
     6 -> PREPARATION PLANT
     7 -> COAL DRILL AND BLAST
     8 -> ALL SUBSYSTEMS

INPUT -> CODE(S)? 8

INPUT -> INTERACTIVE PIT LAYOUT (Y/N)? Y

INPUT -> USE EXISTING FILE
```

*Figure 32.*-- Typical Production Analysis Initializiation.

Following a "no" response to the zoom query and/or upon completion of the zooming activity, the user is asked whether or not he wishes to change the contour interval. Once again, a yes/no response is required here. Should he answer yes, he will be queried for the new contour interval, the screen will be cleared, and a new map will be displayed. Once the user indicates that he is satisfied with the display map by answering "no" to both of the preliminary maps display manipulation the actual pit layout queries begin.

Once the map display is accepted, the cross-hair cursors will be presented on the CRT screen for the user. By manipulating the thumb wheels to position the cross-hairs, and striking any key or character, the user will locate the origin, the X extent and the Y extent of the pit layout. The "X" axis for the purpose of pit layout is assumed to be oriented along the line defined by the first two points entered. In other words, the first two points located and entered through the cross-hair cursors identify the opening edge of the pit being layed out. The "Y" extent, on the other hand, identifies the width of the pit layout area, and the design range indicates to the machine the portion of the total area to be analyzed in the first machine design phase or pass. Having specified the area geometry, the user is next queried for design criteria.

The design criteria is used by the machine to determine a single overburden depth and coal seam thickness values for dragline and other equipment design. As such, the user has the option of using the average for the area specific point at which the overburden depth and coal seam thickness will be used, or utilizing the values at the point of maximum stripping ratio. He indicates his choice by entering a 1, 2, or 3 corresponding to the criteria in a list presented on the screen.

Typical pit layout interaction and the result of the pit layout activity is illustrated in Figure 33. A slight delay will occur following the entry of the design criteria while the computer calculates the necessary values and places them in the #MINE file, and the computer will signal ready once again by sounding a bell on the CRT. At this point, the user will strike the carriage return key to continue, and the overburden depth, coal seam thickness, length and width of the planning area, as well as the total overburden, total coal and coal area identified will be displayed on the screen. The bell sound will indicate that the user may strike the carriage return to continue with the equipment design phase of Production Analysis.

## DRAGLINE DESIGN OPTION MENU

Should the user not elect to perform pit layout, or following successful pit layout, the menu shown in Figure 34 will be displayed on the screen. As shown, he may at this point elect one of the four options. By entering a 1 in response to the option query, he may elect to evaluate the dragline performance at the macro level. If this is done, no interaction need follow in order to perform the analysis, but following

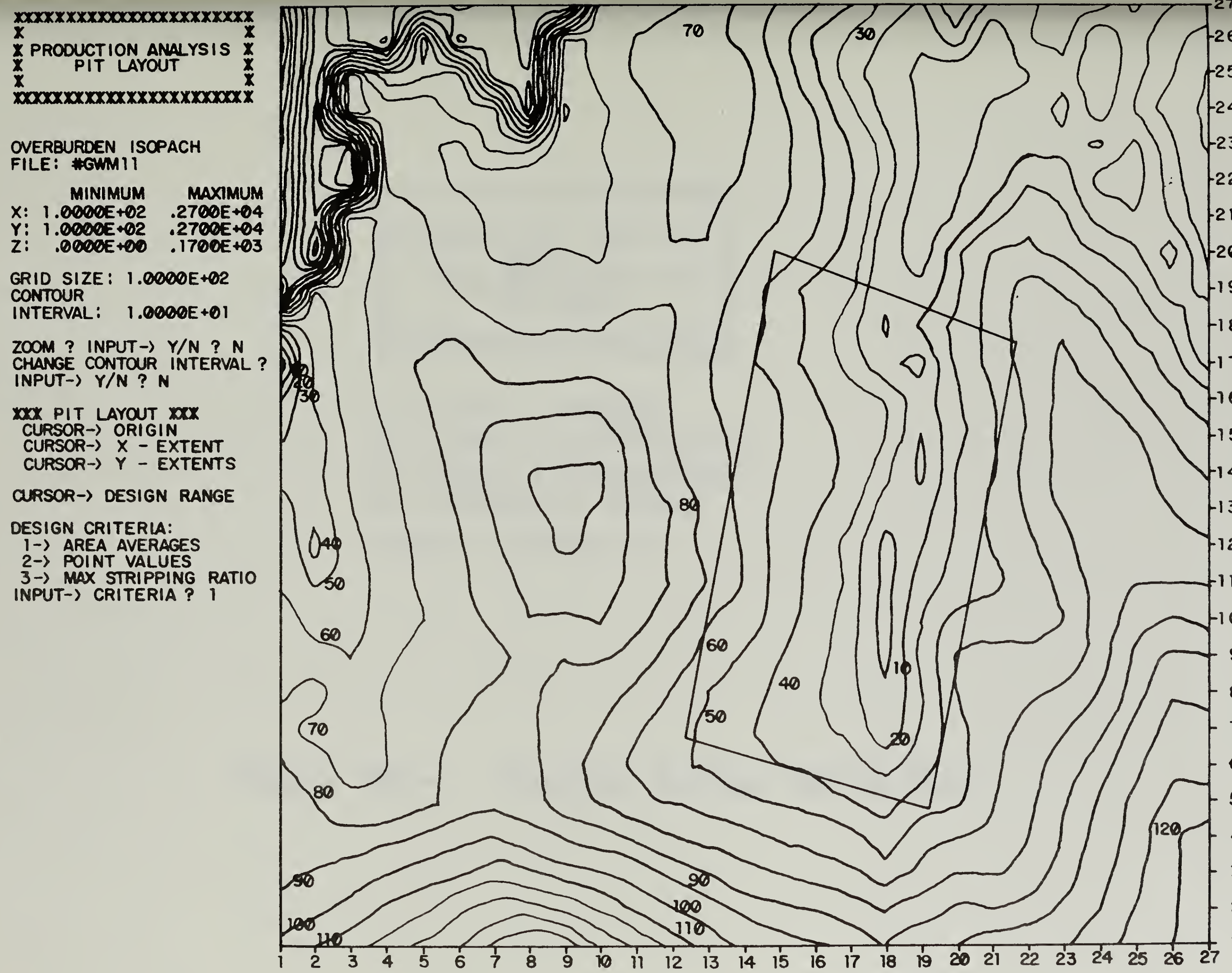



*Figure 33.*-- Typical Pit Layout Interaction & Display.

```
XXXXXXXXXXXXXXXXXXXXXXXX
X                      X
X PRODUCTION  ANALYSIS X
X       LEVEL  1       X
X  DRAGLINE  SUBSYSTEM X
X       OPTIONS        X
X                      X
XXXXXXXXXXXXXXXXXXXXXXXX

1 -> LEVEL 1 (MACRO)
2 -> LEVEL 2 (INTERACTIVE)
3 -> LEVEL 3 (SIMULATION)
Ø -> TERMINATE  DESIGN

INPUT -> OPTION ? 2
```

*Figure 34.*-- Dragline Design Option Menu.

output of the macro level report, the user must simply respond with "yes" or "no" to the query which asks whether or not he would like a line printer listing. Selection of options 2 or 3, however, will result in additional interaction between the user and the programs.

Should option 2 be elected, the second (engineering design) level dragline models will be invoked, and the user will interactively select draglines and pit dimensions for the mine site. Should option 3 shown in Figure 34 be elected, the McDonnell-Douglas dragline simulater will be invoked. Here the interaction scheme is slightly different than the rest of the programs, with the user achieving complete control over the simulation. It should be noted that option 3 is valid only following the election of options 1 and 2, since a dragline must have been selected for simulation. Also, simulation can presently be performed only for 1- pass mining methods. As on all menus, entering of a 0 as the option number will return the user to the next higher level in the interaction scheme, in this case to the macro mine design level additional subsystems may be initialized.

## SECOND LEVEL DRAGLINE DESIGN INTERACTION

The second level dragline design begins with the user providing information by answering initialization queries. Following specification of option 2 on the dragline option menu (Figure 34), the user is queried a line at a time for a dragline stripping design. The first of these queries asks the user whether he wishes to analyze a single or two pass dragline operation. The user will respond to this query by entering a 1 or a 2 for the 1 and 2 pass models respectively. Should a 2 pass system be elected, the user will next be asked whether or not a tandum stripping operation is desired. A "yes" or "no" answer is expected to this query.

Assumming either the 1 pass model has been elected, or the previous query has been answered, the user will next be asked to input information concerning the mine plan characteristics. These include cut width and pit width, or the width of the room available for a spoil pile and bench depth. Also he must respond to a question regarding whether the spoil shall be placed at the top of the coal or not. If a single pass model has been specified, side bench depth may be any positive value, but entry of a value of zero will indicate to the programs that side benching is not desired. With respect to the query regarding whether or not the spoil toe will be at the top of coal or not, an answer of "yes" will indicate to the models that a coal fender is desired.

Following entry of the basic mine plan characteristics, the user will be asked to enter dragline characteristics. These include the dragline purchase price, production rate, available annual operating hours, bucket size, and boom length. The dragline purchase price may be entered as any value greater than or equal to zero, with the value of "0" indicating that there is no constraint to be placed on the purchase price of the dragline. In this case, the optional dragline will be selected should the user elect to optimize the design without regard to purchase price. Likewise, the

production rate may be entered as any value greater than or equal to zero with a value of zero indicating that no constraint on production rate is to be included in the optimization. The third query for dragline characteristics, the annual operating hours, expects the user to respond with any positive value. The operating hours thus far defined include both digging and walking time. Availability for dragline characteristics may become a request for bucket size specifications. The proper response here will be a value indicating the cubic yard bucket size for the dragline. Should the user specify a production rate and fix the dragline operating hours, bucket size will not be requested since it is uniquely determined by these two parameters and the time equations within the model.

The fifth possible input requested is the length of the boom for the dragline which should be specified in feet. The user is cautioned that, depending upon the combination of purchase price, production rate and operating hours specified, the request for bucket size and boom length may vary, since different combinations provide increasing amounts of information to the models for determining unknown parameters. Following specification of the last of the dragline characteristics, there will be a slight delay in the interaction while the model is evaluated, followed by a mode query.

This query indicates that the computer expects the user to select a graphics mode for the desired output. Here the proper responses will be "0", 1, 2, or 3. Table 2 summarizes the plot modes and their interpretation, and Figure 35 illustrates typical responses to dragline design initialization queries for a single pass stripping operation with no side benching and no constraints placed on purchase price or production. Entry of the last initialization response by the user will clear the screen and a casting diagram will be displayed on the screen and/or the plotter depending on the plot mode selected.

Table 2. -- Plot Modes

| MODE | ACTION |
|---|---|
| 0 | Normal (direct, fast) Tektronix CRT Graph |
| 1 | Tektronix CRT Graph - save plot file |
| 2 | Plotter graph only (plot file saved) |
| 3 | Tektronix CRT and Plotter graphing simultaneously. |

```
XXXXXXXXXXXXXXXXXXXXXXXX
X                      X
X     INITIAL PLAN     X
X                      X
XXXXXXXXXXXXXXXXXXXXXXXX

SINGLE PASS OR TWO PASS SYSTEM (1/2) ? 1

XXX MINE PLAN CHARACTERISTICS XXX

INPUT-> CUT WIDTH? 120
INPUT-> PREVIOUS PIT WIDTH? 120
INPUT-> SIDE BENCH DEPTH? 0

INPUT-> SPOIL TOE AT TOP OF COAL (Y/N)? N


XXX DRAGLINE CHARACTERISTICS XXX

INPUT-> DRAGLINE PURCHASE PRICE (MILLIONS $)? 0
INPUT-> PRODUCTION RATE, (MILLION TONS OF COAL/YR)? 0
INPUT-> MAX ANNUAL DRAGLINE OPERATING HOURS? 6000
INPUT-> BUCKET SIZE (YDXX3)? 35
INPUT-> BOOM LENGTH (FT.)? 235
```

*Figure 35.*-- Typical Responses to Dragline Queries.

Once this diagram is complete, the cursor will be moved to the upper left hand corner of the screen and the user may proceed by striking the carriage return key. At this time, he will be informed as to the feasibility or the infeasibility of the design. Once again, following the completion of this output by the computer the user may proceed by striking carriage return and he will be presented with the second level dragline design option menu shown in Figure 34.

## SECOND LEVEL DRAGLINE DESIGN OPTIONS

As shown in Figure 36, the user may at this point choose to: (1) initialize a new plan or (2) optimize the plan using the previously specified plan as a starting point. Alternatively, he may enter a "0" which will terminate the second level dragline design and return the user to the next higher level of interaction (see Figure 31 original flow chart).

Should the user elect option 1 shown in Figure 36, the interaction will follow that just described for initialization of the first plan. However, should option 2 be selected, further information must be provided to the computer through the optimization level queries. These queries include selection of an appropriate objective function: (1) minimum time, or (2) minimum cost per ton of coal uncovered. One or the other of these objectives is selected by entering a 1 or 2 following the query.

Also, the user must answer yes/no queries regarding whether or not pit design variables (pit width and possibly side bench depth) and, dragline design variables (boom length and bucket size) are to be included in the optimization decision variable set. He may elect either one or both of these subsets of decision variables for optimization. Hence, he may request that the computer optimize dragline design for an existing pit, or find the optimal pit for an existing dragline, or both.

Following responses to these queries, the user may next be asked whether or not he wishes to perform the optimization for multiple pit width. This query will be presented only if two conditions are satisified: (1) the user has identified a design range during pit layout, or the design range residing in an existing #MINE file which was elected upon production analysis initialization is large enough to permit multiple pits, and (2) he has selected the pit design variables for inclusion in the optimization set. Once again this is a yes/no response query.

Finally, the user will be asked to specify control values for use by the optimization procedure. Here he must specify a step size for the search procedure and a conversion criteria value. Typically, he will experiment with values to obtain the best performance of the algorithm. The step size regards the average of variation in value for the search out rhythm, and Himmelblau recommends step size of approximately 20% of the difference between an upper and lower bond on the decision variable set. This 20% rule works best if applied to the variable with the smallest range of variability, probably bucket size or side bench depth. The conversion criteria is easier to set, and can be scaled to the user's desire for an exact optimum design. Values here typically will range between one and

```
XXXXXXXXXXXXXXXXXXXXXXXXX
X                       X
X      USER OPTIONS     X
X                       X
XXXXXXXXXXXXXXXXXXXXXXXXX

1 -> INITALIZE  NEW  PLAN
2 -> OPTIMIZE  DESIGN
Ø -> TERMINATE  LEVEL  2  DESIGN

INPUT  OPTION  -> ?  2
```

*Figure 36.*-- Second Level Dragline Design Menu.

ten, with values less than one used only when one is certain that he is fairly close to the optimum initially.

Following entry of the step size and conversion criteria, the user can expect intermediate solutions to be output to the line printer as the nonlinear programming solution code moves toward the optimum design. Once the final design has been found, he will be once again asked to enter a mode for graphical display, as the casting diagram will be automatically drawn illustrating the optimum design. The allowed values which may be entered in response to the mode query and their interpretations are summarized in Table 2.

Typical responses to the optimization queries are illustrated in Figure 37. Once the casting diagram has been produced, the user will be informed as to the feasibility of the design, and he may proceed as in the initial plan specification, being returned to the level two design options menu shown in Figure 36. As shown in Figure 31, when the user concludes the second level design process by entering a "0" in response to the second level dragline menu, he will again be presented with the dragline subsystem general option menu shown in Figure 34.

As illustrated in Figure 31, each time the user selects one of the three possible levels of dragline design analysis and completes the associated analysis, he is returned to the dragline subsystem option menu shown in Figure 34. At this point he may select another level for design, or he may enter a "0". When a "0" response is entered, macro reports are performed with reports being output to the CRT. Following each report, the user must respond to a yes/no query to indicate whether or not he wishes the report to be duplicated on the line printer. This interaction holds for all subsystems except reclamation, which may be analyzed at any of these levels.

```
XXXXXXXXXXXXXXXXXXXXXXXXX
X                       X
X     OPTIMIZATION      X
X                       X
XXXXXXXXXXXXXXXXXXXXXXXXX


XXX SPECIFY OBJECTIVE AND DECISION VARS. XXX

SPECIFY OBJECTIVE:
     1-> MIN. TIME
     2-> MIN COST/TON OF COAL
? 2

INPUT-> PIT DESIGN VARIABLES (Y/N) ? Y

INPUT-> DRAGLINE DESIGN VARIABLES (Y/N) ? Y

INPUT-> MULTIPLE PIT WIDTHS (Y/N) ? N

INPUT-> SIZE, CONVER ? 25.5
```

*Figure 37.*-- Typical Responses to Dragline Optimization Quires.

Volume II of SEAMPLAN is written for a user to apply the system without previously having selected or become familiar with the modeling and computational logic internal to it.

The narrative begins with a discussion of map digitizing for the data entry and review menu and is taken through the first steps of the query - answer interactive format for setting up a mine plan. Not all options are discussed or presented in figures, but key procedures are covered in enough detail in examples for the interested user to investigate every option.

Production analysis examples consist of pit layout queries and dragline designs, which can be interrogated in depth similar to data entry and review options.

Through the step-by-step procedures the user views mining sites prior to mining, designs a mining plan, and, by means of computer, visits the mining area during and after operations.